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THE ASTROPHYSICAL OBSERVATORY OF THE CALIFORNIA INSTITUTE OF TECHNOLOGY

THE International Education Board, at its annual meeting in May, authorized its executive committee to provide for the construction of an astrophysical observatory, equipped with a 200-inch reflecting telescope and many auxiliary instruments, for the California Institute of Technology in Pasadena. A prime purpose of the gift was to secure for the new observatory the advantage, in its design, construction and operation, of the combined knowledge and experience of the strong group of investigators in the research laboratories of the institute and in the neighboring Mount Wilson Observatory of the Carnegie Institution of Washington. The assurance of such cooperation and of the willingness of the institute to assume full responsibility for the establishment of the observatory and its maintenance when completed were accordingly made conditions of the gift. These conditions were unanimously agreed to by the board of trustees of the institute, and the executive committee of the International Education Board has ratified the arrangement and provided for its execution.

The prompt action of the institute trustees was made possible by the fact that on May 13 President John C. Merriam, of the Carnegie Institution of Washington, with the unanimous approval of the executive committee of the institution and of Director Walter S. Adams and his associates of the Mount Wilson Observatory, cordially accepted a request for cooperation from the California Institute and assured the International Education Board of the willingness of the Carnegie Institution to join in the proposed undertaking. Formal approval has thus been given to the continuation and extension of the cooperation which has been in progress between the California Institute and the Mount Wilson Observatory for several years, especially in the study of the astronomical, physical and chemical aspects of the constitution of matter.

The purpose of the astrophysical observatory is thus to supplement and not to duplicate the Mount Wilson Observatory. The chief problems in view are those which naturally fit into the general scheme of research in which the two institutions are engaged. Thus the increased light-collecting power of the 200-inch telescope should permit further studies of the size and structure of the galactic system, the distance,

radiation and evolution of stars, the spectra of the brighter stars under very high dispersion, the distance and nature of spiral nebulae and many phenomena bearing directly on the constitution of matter. The possibility that a 40-foot Michelson stellar interferometer, designed to rotate in position angle, may be attached to the telescope is under consideration. The measurement of the separation of the components of any spectroscopic binary stars within the range of such an instrument would give very complete information regarding the nature of these systems and the masses of their components.

The new observatory will consist of two parts. One of these will comprise the 200-inch telescope, with its building, dome and auxiliary equipment, to be erected on the most favorable high-altitude site that can be found within effective working distance of the associated groups of investigators and their extensive scientific equipment. The other will be an astrophysical laboratory on the campus of the California Institute. This laboratory will serve as the headquarters in Pasadena of the observatory staff and the graduate school of astrophysics. Its equipment will include instruments and apparatus for the measurement of photographs, the reduction and discussion of observations and for such astrophysical investigations as can be made there to the best advantage. Its instruments for the interpretation of astrophysical phenomena will be designed to supplement those of the laboratories of the institute and the Pasadena laboratory of the Mount Wilson Observatory. It will also include an optical shop, but the astrophysical instrument shop will be housed in a separate building, to avoid the effects of the vibration of machine tools.

The value of a telescope depends as much upon the efficiency of the instruments and apparatus used to receive, record and interpret celestial images as upon its optical and mechanical perfection and its light-collecting power. In the present plan special emphasis is therefore laid upon the development of all forms of auxiliary apparatus, such as spectrographs and their optical parts; photographic plates of the various types required for astrophysical and spectroscopic research; radiometers, thermocouples and photoelectric cells; recording microphotometers and other forms of measuring machines; and laboratory apparatus for reproducing or interpreting celestial phenomena. The study of these auxiliaries will be pushed forward as rapidly as possible, in view of the fact that any results obtained will be immediately applicable in existing observatories and laboratories.

An observatory council, consisting of four members of the executive council of the California Institute, has been placed by the trustees in full charge of the design, construction and operation of the astrophysical observatory and laboratory. This council consists of Messrs. Robert A. Millikan, Arthur A. Noyes, Henry M. Robinson and George E. Hale (*chairman*). Through the courtesy of the Carnegie Institution of Washington, Dr. John A. Anderson, of the Mount Wilson Observatory, has been appointed by the observatory council as its executive officer, in direct charge of design and construction. An advisory committee, including Dr. Walter S. Adams, director of the Mount Wilson Observatory; Professor Frederick H. Seares, assistant director; Dr. Charles G. Abbot, secretary of the Smithsonian Institution; Professor A. A. Michelson, of the University of Chicago; Professor Henry Norris Russell, of Princeton University, and Professors Richard C. Tolman, Paul S. Epstein and Ira S. Bowen, of the California Institute, will aid the observatory council and Dr. Anderson in determining matters of policy. Many other leading astronomers, physicists, chemists, meteorologists and engineers in these and other institutions will be called upon for advice and assistance. Dr. St. John and Dr. King, of the Mount Wilson Observatory, who attended the meeting of the International Astronomical Union in Leyden, were requested to look up many matters calling for early decision, and the reports they have presented embody much valuable information kindly given by leading authorities on the design and construction of instruments.

The first decision of the observatory council and the advisory committee, supported by the unanimous opinion of every one consulted in this country and abroad, favored the use of fused silica for the 200-inch and other mirrors of the large telescope. President Gerard Swope and Dr. Elihu Thomson immediately promised the cordial cooperation of the General Electric Company, and work has been undertaken at West Lynn, Massachusetts, under the personal direction of Dr. Thomson. After coating with bubble-free silica the face of a 22-inch disk already in hand, a 60-inch disk will be undertaken, for use as one of the minor mirrors of the telescope. If this proves to be satisfactory, a still larger disk will be made before the casting of the 200-inch mirror disk is attempted.

A mathematical study of the optical design of the telescope, undertaken by Dr. Frank E. Ross, of the Yerkes Observatory, with the kind approval of Director Edwin B. Frost, has confirmed the selection of the ratio F: 3.3 for the 200-inch mirror. The field of sharp definition in the principal focus of such a mirror will be small, but the possibility of photographing extremely faint stars, especially in the spiral nebulae, makes such a powerful concentration of light

highly advantageous. Dr. Ross, who will devote himself to these optical problems during the coming year, also believes that a lens can be designed, for use in the converging beam, which will serve when desired to give a much larger field, also with a short equivalent focal length. It is planned to use a Cassegrainian combination with a ratio of F: 10, having a sharp field 30′ (17 inches) in diameter, for spectrographic and other work. A coudé arrangement similar to that of the 100-inch Hooker telescope, permitting the images of celestial objects to be formed in a constant temperature laboratory, for study with large fixed spectrographs, radiometers or other auxiliary instruments, is also projected.

Dr. Pease has devoted considerable time to a study of the telescope mounting, which has been facilitated by his previous work in designing large instruments. Much additional study will be necessary, however, before even a preliminary design can be adopted, because of recent advances accomplished by telescope builders in this country and abroad. It is our hope that an equatorial design of the fork type, of sufficient rigidity to carry a 40-foot interferometer and meet other severe requirements, will soon be worked out. In this task we have been promised the cooperation of many leading engineers, including Mr. Gano Dunn, Mr. Ambrose Swasey and his associates of the Warner and Swasey Company, and others of wide experience.

The extensive investigation of auxiliary instruments that forms a prime feature of the general scheme has been begun and will soon be developed in various directions. Mr. George Eastman and Dr. C. E. K. Mees have generously agreed to deal with many of the special photographic problems at the research laboratory of the Eastman Kodak Company. A Zeiss recording microphotometer has been ordered and will be used in a comparative study of various forms of this instrument. Dr. Sinclair Smith will attempt to develop and improve the radiometer recently used very successfully by Dr. Abbot with the Hooker telescope in measuring the distribution of energy in the spectra of stars of several types, and work on other auxiliary instruments will soon be commenced.

A comparative study of several possible high-altitude sites has been undertaken. Precise measures of the seeing, rather than estimates, are desirable. Dr. Anderson accordingly devised a simple means of measuring the atmospheric oscillations of star images under a power of 600 with a 4- or 5-inch telescope, and Mr. Ellerman has tested it satisfactorily on Mount Wilson in comparison with the estimates of experienced observers with the 60-inch and 100-inch telescopes. Preliminary observations with this method by Messrs. Ellerman and Humason have been made at Palomar Mountain and "Horse Flats" (north of Mount Wilson), and some tests made by Dr. Abbot and Mr. Moore at Table Mountain show that this site, like the others, deserves careful examination. Dr. Hubble, with the kind cooperation of the authorities of the Grand Canyon National Park, is engaged in the investigation of conditions near the Grand Canyon and at other points on the high plateau area of Central and Northern Arizona. In this work he is having the cordial assistance of Dr. Slipher and the members of the staff of the Lowell Observatory. All this work will be facilitated by the loan of three sets of recording meteorological instruments by Dr. Charles G. Marvin, chief of the U. S. Weather Bureau, who has also kindly supplied us with many meteorological data for various sites in California and Arizona.

The policy of the observatory council, in all phases of this undertaking, is to bring into cooperation the most competent authorities in their respective fields. In the operation of the telescope the same policy will be maintained which has been followed in the past at the California Institute and the Mount Wilson Observatory of inviting eminent authorities in astronomical and astrophysical research to use the instrument in connection with their investigations. It is hoped that in this way the astrophysical observatory will also become an international center for research. The willingness of so many leading men of science to lend their assistance and the fact that all decisions have been unanimous give promise of such results as the broad-minded attitude of the International Education Board most certainly deserves.

THE CHEMICAL CONSTITUTION OF RESPIRATION FERMENT[1]

I

FERMENTS are substances which effect chemical reaction in living matter. It is one of their properties that they occur in living matter in extremely small concentration. It has not been possible thus far to measure the amount of a ferment present anywhere. It is also one of their properties that they are unstable. In all attempts to isolate the ferments they are usually destroyed, and we have not yet succeeded in the preparation of a pure ferment. Because of this it is not known how the ferments are chemically constituted, and hence it is not understood how chemical reactions occur in living matter.

[1] Address before the Kaiser Wilhelm Gesellschaft on February 22, 1928. Published in *Die Naturwissenschaften*, Vol. 16, p. 345, May 18, 1928. Translated by Dr. W. A. Perlzweig, the Johns Hopkins Hospital.

The ferment which I shall discuss is the respiration ferment, of which it has been said that it rules the organic world, for in everything that happens in living matter respiration furnishes the driving force. Chemically speaking, respiration is an oxidation by the oxygen of the air, and hence the respiration ferment is a substance which takes up the atmospheric oxygen and transfers it to the organic substances. This ferment is, as we have found, in its chemical constitution related to the red pigment of the blood, hemoglobin. I shall at first describe the significant properties of the red blood pigment and of its related substances and will also show that these properties are as well the properties of the respiration ferment.

Hemoglobin, the red blood pigment, consists of a colorless component, the basic protein globin, and of a colored component, hemin. These components can be separated. When, however, they are brought together under certain conditions they unite, as Robert Hill, of Cambridge, has recently shown, to form hemoglobin again. In this reaction the globin can be replaced by other and simpler bases, for example, by pyridin or nicotin. Then instead of the hemoglobin we obtain hemopyridin or hemonicotin. These compounds, of which many can be prepared, are indeed different in their chemical properties, but their specific and biologically important reactions are similar, and all of them depend upon the hemin, which therefore must be regarded as the reactive nucleus of the hemin compounds.

Hemin was discovered in 1853 by Teichmann by the acid hydrolysis of hemoglobin and obtained in a crystalline form. Hemin is a complex iron compound, more exactly a tetrapyrrole iron compound, in which the iron is bound to the pyrrole nitrogen. Its structure is relatively simple, and its molecular weight is 650. Its constitution has been worked out by Nencki, Küster, Willstätter and Hans Fischer.

Just as hemin is the reactive nucleus of hemin compounds, so is iron the reactive nucleus of hemin. The specific and biologically important reactions of hemin are reactions of complex iron compounds.

II

Of all the hemin compounds the one most clearly worked out is hemoglobin. The iron of hemoglobin reacts in a reversible manner with molecular oxygen according to the equation

$$Hb + O_2 \rightleftarrows HbO_2 \qquad (1)$$

in which *one* atom of iron combines with *one* molecule of oxygen.

It is on this reaction that the function of the hemoglobin in the body is based. In the capillaries of the lungs hemoglobin takes up oxygen, transports it via the blood stream throughout the body and gives it up by dissociation in the capillaries of the tissues in which the oxygen pressure is lower. The oxygen then diffuses through the capillary walls into the tissue cells, where it is utilized for respiration. Thus hemoglobin is a transport agency for oxygen, and not a catalyzer or a ferment. It does not transfer oxygen to organic molecules, but it merely transports the oxygen from one place in the body to another place. A catalytic action of hemoglobin would even be at variance with its physiologic function. For it only delivers to the tissues the oxygen which it has taken up in the lungs, but does not utilize it on its way in any chemical reaction.

III

The iron of the hemoglobin reacts not only with oxygen but also carbon monoxide, reversibly, according to the equation

$$Hb + CO \rightleftarrows HbCO \qquad (2)$$

in which *one* atom of iron takes up *one* molecule of CO.

If oxygen and CO are permitted to react simultaneously with hemoglobin, then the two gases compete for the iron atom and according to the partial pressures the CO suppresses the oxygen or *vice versa*:

$$HbO_2 + CO \rightleftarrows HbCO + O_2 \qquad (3)$$

Finally, equilibrium is obtained in the following manner:

$$\frac{HbO_2}{HbCO}\,\frac{CO}{O_2} = K \qquad (4)$$

which means that the distribution of hemoglobin between oxygen and CO is completely determined by the ratio $\frac{CO}{O_2}$, *i.e.*, the ratio of the partial pressures of the two gases. It is on the replacement of oxygen by carbon monoxide as in equation (3) that the poisonous effect of carbon monoxide depends. When the pressure of CO in the respired air is overwhelmingly great the carbon monoxide replaces the oxygen on the hemoglobin. It is then that the hemoglobin can no longer transport any oxygen, and the tissues of the body are asphyxiated.

CO-hemoglobin has the remarkable property, discovered in 1897 by John Haldane, that it is split into CO and hemoglobin upon being exposed to light.[2]

[2] The first observation concerning the sensitivity to light of an iron-carbonyl compound was made by L. Mond and C. Langer (*Jour. Chem. Soc.*, 59, 1090, 1891). They found that $Fe(CO)_5$ splits off CO on exposure to light.

On the other hand, oxyhemoglobin is quite stable in light. Hence the distribution of hemoglobin between CO and O_2 is altered on exposure to light. If hemoglobin is brought into equilibrium with CO and O_2 in the dark and is subsequently exposed to light the CO compound diminishes in concentration and the O_2 compound increases until a new stationary equilibrium is reached, which depends upon the intensity of the illumination.

In principle the free reduced hemin and the compounds of hemin with other bases behave like hemoglobin, only the velocity of the reaction and the affinity of the iron atom towards O_2 and CO are altered. This explains the fact that *one* hemin compound is capable of catalytic action, as the hemonicotin, while another hemin compound, as hemoglobin, has no such capacity.

IV

Hemoglobin predominates in the blood of the higher animals. Other hemin compounds occur, as discovered by MacMunn in 1886, in *cells* and indeed not only in the cells of hemoglobin carrying animals, but also in *all* cells. Keilin demonstrated in 1925 the presence of cell hemins in plants, bacteria and yeasts. In the course of evolution hemin must have appeared in nature earlier than hemoglobin, as MacMunn had already surmised.

The work of MacMunn was neglected and partly doubted, and it was only recently that Hans Fischer and Keilin brought it the credit that it deserves. Hans Fischer isolated porphyrin, *i.e.*, hemin minus the iron, from yeast and showed that yeast can synthesize hemin from porphyrin and iron. Keilin confirmed and extended the discovery of MacMunn in an excellent spectroscopic investigation and called the cellular hemin cytochrome.

Such are the fundamental facts of the chemistry and physiology of hemin compounds, of which we shall make use in the following discussion. I repeat them: The universal distribution of hemin in nature; the reversible reaction of its iron atom with oxygen; reversible reaction of its iron atom with CO; the distribution between O_2 and CO according to the equation of distribution, and finally the sensitivity to light of the CO compound.

V

Since Claude Bernard discovered in the middle of the preceding century carboxy-hemoglobin it has been believed that CO combines in the organism exclusively with hemoglobin and not with cellular substances. Particularly illuminating was an investigation of Haldane in 1895. When he placed mice in air containing CO, the CO displaced the oxygen in the hemoglobin, and the mice died for lack of oxygen. But when he raised the oxygen pressure to two atmospheres, then the total hemoglobin remained indeed combined with the CO, but the oxygen which was in a state of physical solution in the blood increased tenfold. In this case the mice did not die, because the physically dissolved oxygen sufficed to supply the tissues.

This experiment indicates clearly that the CO even at pressures at which it does not affect the respiration of the cells still combines with the hemoglobin, but it does not indicate that the respiration ferment is incapable of reacting with CO at *any* CO pressure.

In fact it developed that in this case only quantitative differences are involved. If the pressure of CO is permitted to rise to about one atmosphere then the respiration ferment combines with the CO. In this case the respiration of the cells ceases because the CO compound of the ferment can not transfer catalytically any oxygen. The catalytically active iron atom of the respiration ferment is blocked, as it were, by the carbon monoxide. If the CO pressure is permitted again to drop, normal respiration reappears. The respiration ferment (Fe) therefore reacts, just as the hemoglobin, *reversibly* with carbon monoxide:

$$Fe + CO \rightleftarrows FeCO \qquad (5)$$

We have discovered this reaction in our investigations on yeast and later we recognized it as a general cellular reaction.

If the CO pressure is kept constant and the O_2 pressure is permitted to rise then the effect of the CO upon the respiration decreases, to disappear completely at very high oxygen pressures. It is possible, therefore, to suppress the effect of CO upon the respiration ferment by means of oxygen.

From our measurements of respiration at various CO and O_2 pressures we deduced the law according to which the distribution of the respiration ferment between CO and O_2 occurs. We found that

$$\frac{FeO_2}{Fe(CO)_2} \times \frac{CO}{O_2} \qquad (6)$$

is constant. Hence the respiration ferment is subject to the same distribution equation as hemoglobin. Only the numerical values of the constants are different, the constant for the hemoglobin equation being 0.01, the constant for the ferment equation about 10.

Furthermore: If the respiration of the cells is inhibited in the dark by means of CO, the cells being then exposed to light, the inhibition of the respiration diminishes at once and disappears completely on excessively intense illumination. Thus we see that

light displaces the distribution of the respiration ferment between CO and O_2 in favor of the oxygen, exactly in the same manner in which light effects the distribution of hemoglobin between the two gases. Also in this case the differences between the hemoglobin and the respiration ferment are only quantitative. In order to effect photochemically the distribution of hemoglobin very great intensity is required; on the other hand, the intensity of light required to effect the distribution of the respiration ferment is one ten thousandth of the intensity of sunlight.

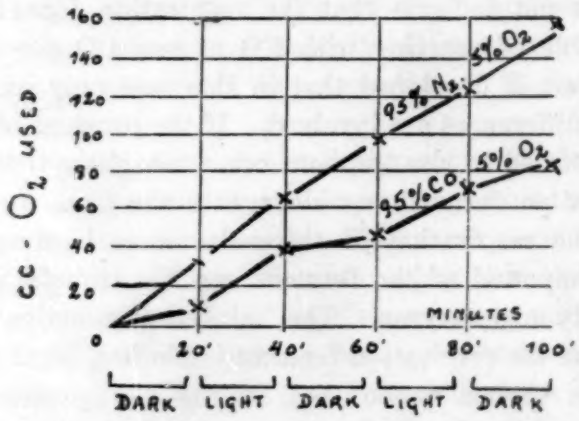

FIG. 1. Effect of carbon monoxide upon the respiration of living cells (dark and light).

The course of an experiment with respiring cells is graphically shown in Fig. 1. The abscissas show the time *t*, and the ordinates the amounts of oxygen respired. The slope of the line against the abscissa represents the rate of respiration. The experiment began in the dark, and exposure to light began after twenty minutes. After another twenty-minute period it was placed in the dark again, etc. The lower line shows the behavior in carbon monoxide: at each change from light to darkness and *vice versa* there is seen a sudden bend; and also it is seen that the respiration is less in the dark and greater in light. The upper line shows the relation of respiration under exactly the same conditions but without carbon monoxide. This line does not show any effect of illumination.

Summarizing, we have found that the respiration ferment has three characteristic properties of hemoglobin: It reacts reversibly with CO and O_2; it is distributed between CO and O_2 according to the definite equation of distribution; in combination with CO it is sensitive to light.

VI

The differences between hemoglobin and the respiration ferment are: hemoglobin, in contrast to the respiration ferment, does not act as a catalyst. Hemoglobin binds CO more firmly than the respiration ferment, and this combination is decomposed by

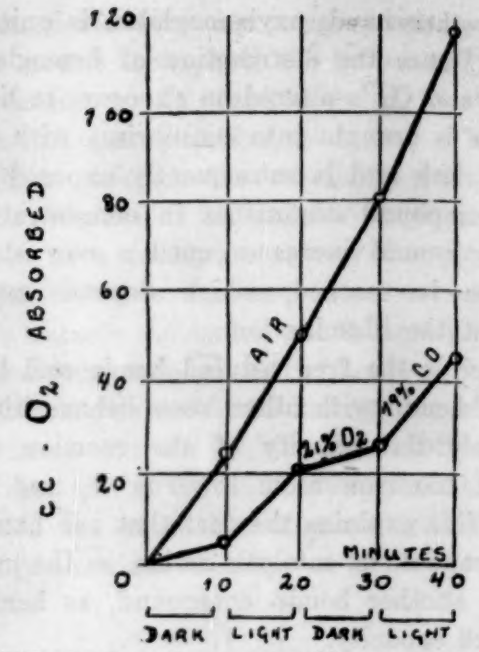

FIG. 2. Effect of carbon monoxide upon the catalytic action of hemopyridin (dark and light).

light with much greater difficulty than the CO respiration ferment compound.

The properties of the respiration ferment are approached more closely if the globin is removed from the iron-carrying component of hemoglobin. Free

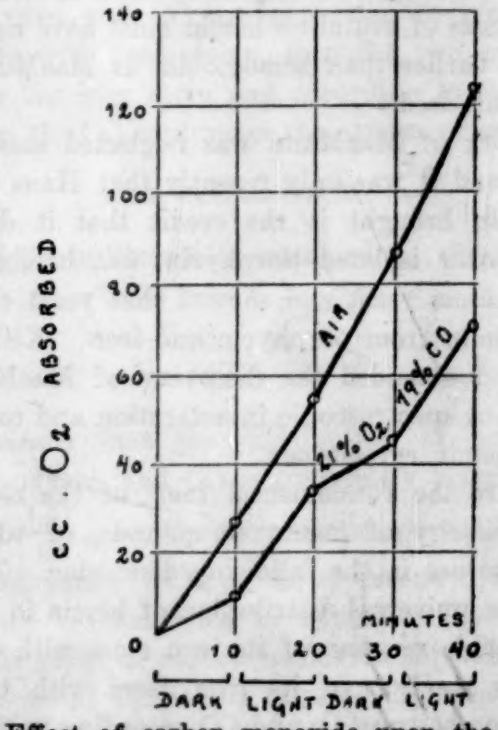

FIG. 3. Effect of carbon monoxide upon the catalytic action of hemonicotin (dark and light).

hemin behaves as a catalyst and, as was shown by D. C. Harrison, of Cambridge, it is capable, for example, of oxidizing catalytically cystein in aqueous solution to cystin. This catalysis, according to the investigation of H. A. Krebs, is inhibited by the same pressure of CO as is respiration. Still the sensitivity to light of CO-hemin is only one ten thousandth of the sensitivity to light of the CO-respiration ferment compound. Even this discrepancy can be overcome.

If hemin is combined with pyridin or nicotin, we obtain powerfully active catalysts whose Fe is capable of transferring two thousand molecules of oxygen to cystein. The CO compounds of these hemin derivatives were decomposed by light of one ten thousandth of the intensity of sunlight, according to H. A. Krebs. They are therefore just as sensitive to light as the CO compound of the respiration ferment. The above described experiments with living cells could be repeated by us without living cells in simple solutions. In Figs. 2 and 3 I am showing two illumination experiments in simple solutions in which hemopyridin and hemonicotin were used as the catalysts. Both these figures are very similar to the first figure. Thus if one chooses appropriate hemin compounds for catalysts one can obtain a system which bears the same relation towards CO and light as the respiring living substance.

VII

If the respiration ferment is a hemin compound, and indeed one finds spectroscopically a hemin compound in all cells (Keilin's cytochrome) then we might believe that the respiration ferment and cytochrome are identical. That this is not correct is shown by the following experiments:

(1) Cytochrome-hemin occurs in considerable concentration in yeast. If, however, one attempts to determine quantitatively the ferment-hemin (for which we have a method at our disposal which is supposed to indicate the presence of one millionth of one per cent.) then, as was found by Mr. F. Kubowitz, the amount of ferment present is zero. This means that only a minimal fraction of the cell hemin is ferment hemin.

(2) While hemoglobin, the respiration ferment, and many other hemin compounds which we have investigated react in the reduced state with O_2 and CO, cytochrome on the other hand does not combine either with oxygen or with CO, at least not at a pressure of one atmosphere. Therefore, cytochrome represents a hemin compound which has lost the characteristic properties of hemin. Just as hemoglobin is a denatured respiration ferment, because its Fe atom no longer behaves catalytically, so is also cytochrome a denatured ferment whose Fe atom is no longer capable of reacting with oxygen. Thus, the respiration ferment and cytochrome are different substances which differ by their respective concentrations in the cells and by their behavior toward O_2 and CO. Incidentally, this again confirms the old experience that substances which occur in the cells in any considerable concentration are *not* ferments.

VIII

It follows from the above that there are two conditions which make it difficult to identify the respiration ferment as hemin: the minute concentration of the ferment and the great concentration of the cell hemin which is not ferment hemin. The inactive cell hemin obscures the ferment hemin in all analytic procedures, whether chemical or spectroscopical. It must, therefore, suffice to state that the respiration ferment behaves as a hemin and is, therefore, a hemin, or a method must be found which can differentiate the ferment hemin from the other hemins of the cell. Such a method is the following:

We inhibit the respiration of living cells by CO and then expose to light of different wave-lengths. On illumination the respiration rises, as we have seen above. To this the new observation can be added that the respiration rises to *different* levels according to the wave-length which we employ. Thus, if we render the intensities of the different wave-lengths equal, *i.e.*, we expose the cells to light of different colors but of equal intensities, then we find that the effect upon the respiration in the ultra-violet at 366 μμ is very small, great in blue, again small in green, etc. If we represent the effect of the light in relation to its wave-length graphically we obtain a curve which we designate as the action curve. The varying effects of the wave-length may have various reasons, but by all means the most probable cause lies in the fact that the respiration ferment absorbs light of different wave-lengths to a different extent. In such a case our action curve is nothing else but an absorption spectrum of the respiration ferment. If this is accepted then the absorption spectrum of the respiration ferment can be determined by means of exposing cells in carbon monoxide to lights of different colors but of equal intensity and by comparing the results; or by varying the intensities of the different colors in such a way that equal results are obtained.

It is clear that with such an arrangement the catalytically inactive cell hemins, such as the cytochrome, do not interfere. It is true that the inactive hemins absorb light just as the ferment hemin does, but the light absorbed by the inactive hemin has no effect upon respiration. Only that light which is absorbed by the respiration ferment affects respiration. It is of equally little account in the above procedure that the concentration of the ferment is infinitely small, since we measure infinitely great effects of the ferment in relation to the amount of ferment present.

IX

Since the principle of determining the absorption spectrum of a catalyst from the photochemical effect upon the catalysis is new, it was desirable to test it out under simple conditions before applying it to a living system. We sought to prove first that it is the difference of absorption only which determines the different effects of the colors.

Particularly adaptable for this purpose is the hemonicotin model which is demonstrated by a great sensitivity to light. With this model the absorption spectrum of the catalyst can be taken photometrically or bolometrically, to begin with from a clear aqueous

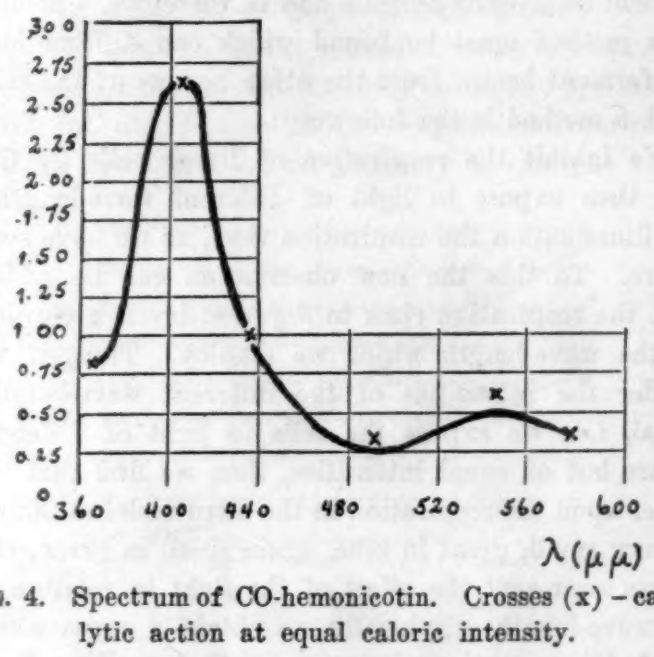

FIG. 4. Spectrum of CO-hemonicotin. Crosses (x) – catalytic action at equal caloric intensity.

solution in which only the catalyst itself—hemonicotin—absorbs light. Then the action curve can be photographed in which the catalysis is being inhibited by CO and stimulated by different colored lights, and the effect of the light is represented as a function of the wave-length. If our assumption is correct, the directly measured absorption curve and the action curve must have the same form.

In our experiment we have employed six regions of the spectrum, *i.e.*, six lines of the mercury vapor lamp: ultra-violet—366 μμ, violet—408 μμ, blue—436 μμ, blue green—492 μμ, green—546 μμ, and yellow of 578 μμ. The results are shown in the curves of Figs. 4 and 5. The drawn-out line shows the bolometrically measured absorption spectrum. The crosses indicate the actions observed with light of different colors but of equal intensity, referred to the blue mercury line of 436 μμ. The light intensities were equal either in calories (Fig. 4) or in quanta (Fig. 5). In both cases the crosses fall very closely upon the absorption curves. Thus no matter whether one calculates in calories or quanta intensities the observed catalytic action yields in effect very closely the absorption spectrum. This shows that the assumption agrees with our method. The spectrum of a catalytically active hemin complex can be obtained from the photochemical effect upon the catalysis.

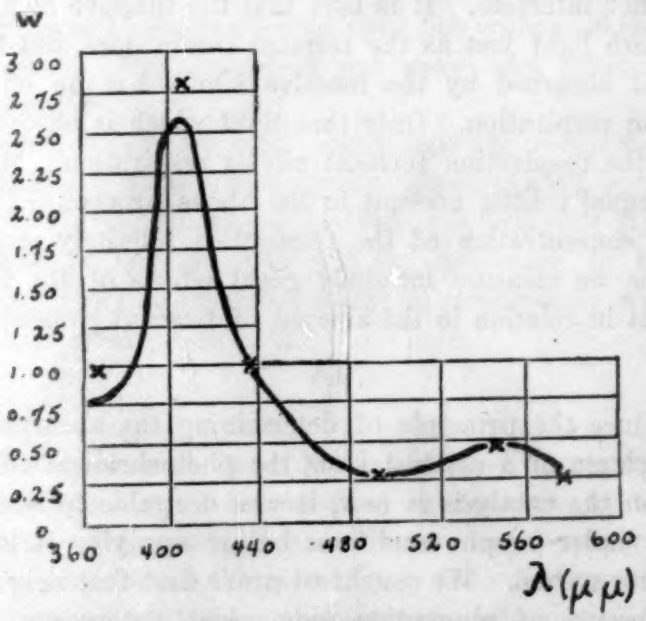

FIG. 5. Spectrum of CO-hemonicotin. Crosses (x) – catalytic action at equal quantum intensity.

X

In applying this method to living material we used yeast cells. Their respiration was inhibited by means of CO. Then they were exposed to different lights of equal (quanta) intensity and the action upon respiration was measured. The spectral regions used were again the above six mercury lines and in addition two regions in the red which were isolated from the radiation of a metal filament lamp.

Before showing you the results I shall throw upon the screen the spectrum of CO-hemin in order to orient ourselves in the general form of the hemin spectrum (Fig. 6). The characteristic features are

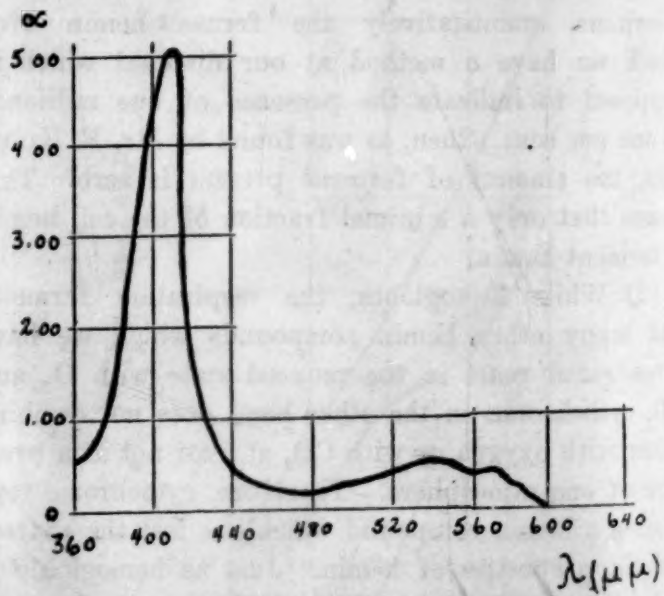

FIG. 6. Spectrum of CO-compound of (reduced) hemin (taken bolometrically and photometrically).

the high and the relatively sharp band in the blue, the minimum in the blue green, a flat band in the green yellow, and a very slight absorption in the red. It is because of this that all these pigments in thick layers appear red as blood.

Now I shall show you the absorption spectrum of the respiration ferment (Fig. 7). You will see here the typical hemin spectrum: the high and relatively sharp band in the blue, the minimum in the blue green, the flat band in the green yellow and the very slight absorption in the red.

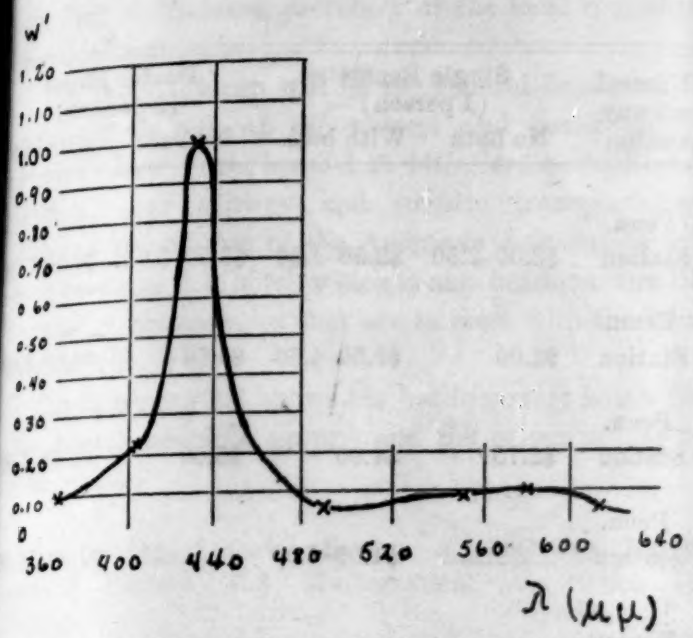

FIG. 7. Spectrum of the respiration ferment. (Crosses, x,-catalytic action on illumination with lights of equal quantum intensity).

XI

On closer examination of the spectra of the respiration ferment and of the known hemin compounds a difference is revealed. The maximum of the blue band for the respiration ferment lies at 436 μμ and at 408 μμ for CO-hemin. The spectra of none of the known hemin compounds coincide completely with that of the respiration ferment, the latter being displaced towards the red in respect to the former.

It must be recalled here that the respiration ferment is not in solution in the cell but is embedded in the solid cellular components of the surfaces. The spectrum of the respiration ferment which I have shown is not of the dissolved but of the solid ferment, whereas the spectra of the other hemin compounds were taken from solutions. It is known that a displacement of the spectrum of a pigment would be associated with a fixation of the pigment upon the cellular substance. Thus the spectrum of chlorophyll bound to the (solid) cellular phase is displaced to 20 μμ towards the red in relation to the spectrum of chlorophyll in solution. This corresponds to the direction and order of magnitude of the displacement shown by the ferment-hemin in relation to the dissolved hemin. This does not mean that the state of aggregation alone determines the displacement, for the effect may also be due to chemical differences.

In concluding, I wish to acknowledge the credit due for a great part of the above described investigation to my coworkers, Mr. Negelein and Mr. Krebs.

BERLIN-DAHLEM OTTO WARBURG

EUGEN AMANDUS SCHWARZ

ALL entomologists will be saddened by the news that Dr. E. A. Schwarz died in Washington, of pneumonia, on October 15. He was born at Liegnitz, Silesia, on April 21, 1844, and was therefore more than eighty-four years of age when he died. In his early years he studied in the Universities of Breslau and Leipzig, and came to America in 1873, taking a post in the newly founded Museum of Comparative Zoology at Cambridge. On the death of the elder Agassiz, he joined his friend, Henry G. Hubbard, in the establishment of a scientific association at Detroit, Michigan. Alone or with Hubbard he made expeditions to Florida and to the Lake Superior region, and in 1877 was sent by John L. Leconte to Colorado on a collecting trip. In the summer of that year he became connected with the entomological service of the U. S. Department of Agriculture and remained under the federal government until the time of his death. Dr. Schwarz was a coleopterist by choice, but had a very wide range of knowledge concerning insects in general. He was not only a very learned man, but a most kindly one, and possessed a remarkable sense of humor. Some of his clever sayings will be quoted for years to come.

It has been said that he was the most learned entomologist in America; to his quiet influence is doubtless due much of the great advance which has been made in this country in sound and fine work. He was one of the founders of the Entomological Society of Washington, and for some years before his death he had been its honorary president. The *Proceedings* of this society for the first thirty years or more of its existence are replete with short notes and longer articles from his pen covering a vast field of biological observation.

In a way, he shunned publicity, but nevertheless was known and appreciated by a wide circle, not only of entomologists, but also of people engaged in other kinds of work. To respect for his learning were added admiration and affection for his other characteristics.

Dr. Schwarz was also one of the founders of the Biological Society of Washington. He joined the American Association for the Advancement of Science at the first Detroit meeting in 1875. I think that the published record which shows him first as a member at the first Boston meeting of 1880 must be wrong.

L. O. HOWARD
U. S. DEPARTMENT OF AGRICULTURE

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

HEADQUARTERS HOTELS AND HOTEL ARRANGEMENTS FOR THE FIFTH NEW YORK MEETING

THE following information concerning hotel arrangements for the fifth New York meeting (December 27, 1928, to January 2, 1929) is supplied by

Hotels	Nearest subway station	Single Rooms (1 person) No bath	Single Rooms (1 person) With bath	Double Rooms (2 persons) No bath	Double Rooms (2 persons) With bath
Hotels near Pennsylvania Station:					
Breslin, Broadway at 29th (Lexington 2260)	Penn. Station	$2.00–2.50	$2.50–3.50	$3.50–5.00	$4.00–7.00
Imperial, Broadway at 32nd (Lackawanna 2000)	Penn. Station	$2.00	$2.50–4.50	$3.50	$4.00–7.00
McAlpin, Broadway at 34th (Pennsylvania 5700)	Penn. Station	$2.75	$4.00	$5.00	$6.50–7.00
Pennsylvania, 7th Ave. at 33rd (Pennsylvania 5000)	Penn. Station	.....	$4.00–6.00	.....	$7.00–10.00
Hotels near Times Square:					
Astor, Broadway at 44th (Bryant 2100)	Times Square	$3.00–3.50	$4.00–7.00	$5.50	$6.50–10.00
Lincoln, 8th Ave. at 44th (Lackawanna 1400)	Times Square	.....	$3.00–5.00	.....	$5.00–7.00
Paramount, 46th, west of Broadway (Chickering 7580)	Times Square	.....	$3.50–5.00	.....	$5.00–8.00
Park Central, 7th Ave. at 55th (Circle 8000)	B'way, 50th	.....	$4.00–7.00	.....	$7.00–10.00
Piccadilly, 45th, west of Broadway (Chickering 7100)	Times Square	.....	$3.00–4.50	.....	$4.50–6.00
President, 234 W. 48th (Chickering 7904)	B'way, 50th	.....	$2.50–3.50	.....	$3.50–5.00
Times Square, 43rd, west of Broadway (Lackawanna 6900)	Times Square	$2.00	$3.00	$3.00	$4.00
Hotels near American Museum:					
Bretton Hall, Broadway at 86th (Endicott 8000)	B'way, 86th	$2.50–3.00	$3.00–4.00	.....	$4.00–6.00
Endicott, Columbus Ave. at 81st (Trafalgar 6400)	B'way, 79th	$2.50	$3.50	$4.00	$5.00
Majestic, Central Park W., at 72nd (Endicott 1900)	B'way, 72nd	$3.00	$4.00	$5.00	$6.00–8.00
Other hotels:					
Commodore, Grand Central Terminal (Vanderbilt 6000)	Grand Central	.....	$4.00–6.00	.....	$8.00–10.00
Marseilles, Broadway at 103rd (Riverside 7680)	B'way, 103rd	$2.50	$3.00	$3.50	$4.50
Murray Hill, Park Ave. at 41st (Lexington 2300)	Grand Central	$3.00–5.00	$4.00–6.00	$5.00–7.00	$6.00–8.00
Westminster, 420 W. 116th (Cathedral 7100)	B'way, 116th	.....	$2.50–3.00	.....	$4.00–5.00

Dr. Sam F. Trelease, secretary of the local committee for the meeting.

The Hotel Lincoln will be the general headquarters hotel. It is one of the newest and best-equipped hotels in New York, located at 44th Street and Eighth Avenue, near subway and surface transportation. Many of the officers of the American Association will have rooms at this hotel, which is also headquarters for several of the societies that are to meet with the association this year.

The following list shows the headquarters hotels for the several scientific groups and the organizations in each group:

Mathematics, *Lincoln.* Section A, American Mathematical Society and Mathematical Association of America.

Physics, *Lincoln.* Section B, American Physical Society and American Meteorological Society.

Chemistry, *Lincoln.* Section C.

Astronomy, *Lincoln.* Section D and American Astronomical Society.

Geology and Geography, *Astor and Bretton Hall.* Section E, Geological Society of America, Society of Economic Geology, Paleontological Society of America and Mineralogical Society of America, all at *Astor.* Association of American Geographers and National Council of Geography Teachers, at *Bretton Hall.*

Zoological Sciences, *McAlpin.* Section F, American Society of Zoologists, Entomological Society of America, American Association of Economic Entomologists, American Society of Parasitologists and Phi Sigma Biological Research Society.

Botanical Sciences, *Lincoln.* Section G, Botanical Society of America, American Phytopathological Society, American Society of Plant Physiologists, Sullivant Moss Society and American Fern Society.

Societies related to both zoology and botany, *Lincoln and McAlpin.* American Society of Naturalists and American Microscopical Society, at *McAlpin.* Ecological Society of America, at *Lincoln.*

Anthropology, *Endicott and Park Central.* Section H, American Anthropological Association and American Folk-Lore Society, at *Endicott.* Archaeological Institute of America, at *Park Central.*

Psychology, *Pennsylvania.* Section I and American Psychological Association.

Social and Economic Sciences, *Lincoln.* Section K.

Historical and Philological Sciences, *Marseilles.* Linguistic Society of America.

Engineering, *Lincoln,* Section M.

Medical Sciences, *McAlpin.* Section N.

Agriculture, *McAlpin.* Section O, American Society of Agronomy, Society of American Foresters, American Society for Horticultural Science, Potato Association of America and Association of Official Seed Analysts.

Education, *Pennsylvania.* Section Q.

Science in General, *Lincoln and McAlpin.* American Association of University Professors and Gamma Alpha Graduate Scientific Fraternity, at *Lincoln.* American Nature-Study Society, at *McAlpin.*

Headquarters hotels have not yet been designated by the following organizations: Metric Association, Section L, History of Science Society, Geneticists Interested in Agriculture, Gamma Sigma Delta Fraternity, Society of Sigma Xi and Sigma Delta Epsilon Graduate Women's Scientific Fraternity.

Information about the headquarters hotels, and about a few others that will be convenient and desirable for those attending the meeting, is given below. Some of the names are grouped according to the locations of the hotels. Prices are rates per day. Telephone numbers are in parenthesis.

Members planning to attend the New York meeting should reserve hotel rooms at once by writing directly to the hotels. *Do not write the local committee on arrangements.* In making reservations, state type of room desired, approximate price and date of arrival. Only by immediate reservation can a member be assured of securing the accommodations he desires. The number of lower-priced rooms in some hotels is relatively small, but rooms with twin beds are available at most hotels. Two persons sharing the same room will obtain accommodations at a rate lower than for separate single rooms. The hotel managements reply promptly to requests for reservations. If a suitable room can not be engaged at the hotel first chosen another hotel should be tried immediately.

Of course there are many more good hotels in New York than are given in the tabulation above. Information about additional hotels may be secured by addressing the office of the permanent secretary of the American Association for the Advancement of Science, Smithsonian Institution Building, Washington, D. C.

BURTON E. LIVINGSTON,
Permanent Secretary

SCIENTIFIC EVENTS

RESOLUTIONS OF THE AMERICAN FISHERIES SOCIETY

THE following resolutions were passed by the American Fisheries Society at its fifty-eighth annual convention held in Seattle from September 28 to 31:

The American Fisheries Society approves the fish cultural policy of the U. S. Bureau of Fisheries and its program of biological and technological research along practical lines; and urges the adoption by congress of the five-year program recommended by the Committee on Merchant Marine and Fisheries at the last session of congress providing for the extension of the work of the Bureau of Fisheries.

In view of the growing menace to the fisheries through encroachments of hydro-electric developments on our streams, the American Fisheries Society urges that streams of real importance to the fisheries' resources be determined and designated without delay and that such streams be withdrawn from further power development until urgent public need for such development is clearly shown, and until a known method whereby anadromous fishes shall not be interrupted in their nuptial journey had been provided for without any doubt.

The American Fisheries Society strongly approves the efforts of the U. S. Bureau of Fisheries and the several states interested in the problem to devise an efficient method of preventing the enormous loss of fishes in irrigation ditches, and we urge that the efforts be continued until a satisfactory solution is found and applied.

It is also urged that sufficient appropriations be provided by congress for a similar investigation tending toward the solution of the fishway problem.

In view of the fact that many important fisheries in industrial districts have been destroyed by pollution of the waters; and that other important fisheries are in imminent danger from the same source; and that the State of Pennsylvania has adopted a very effective method of dealing with this problem, it is therefore urged by the American Fisheries Society that similar methods be adopted by other states.

It is also recommended that the establishment on unpolluted waters of industries having injurious wastes be delayed until satisfactory methods of handling such wastes can be applied.

The American Fisheries Society recognizes the existence of the various fisheries conservation problems common to the United States and Canada—in particular, of those relating to the salmon fisheries of the Great Lakes, and recommends the immediate adoption of appropriate treaties looking towards the restoration of such international fisheries as are depleted and the adoption of uniform regulations where such are desirable; and to a closer cooperation in dealing with such matters.

The American Fisheries Society approves the work accomplished by the Western Food and Game Fish Protective Association through the cooperation of sportsmen, commercial fishery operators and others interested in the preservation of the fisheries; and urges a closer cooperation between these various interests throughout the country in securing constructive action on fishery problems.

Whereas, There has been an increase of considerable proportion in commercial troll fishing in the Pacific Ocean off the coasts of Alaska, British Columbia, Oregon, Washington and California, during recent years; and

Whereas, There are numbers of immature salmon taken, especially during the early spring months; and

Whereas, This has resulted in a depletion of the salmon supply; and

Whereas, It is evident that in the interests of conservation and perpetuation of a major industry that some remedial legislation is needed; now, therefore, be it

Resolved, By the American Fisheries Society, in convention assembled, at Seattle, Washington, this 31st day of August, 1928, that the several legislatures of California, Oregon and Washington, as to their respective coasts, the Department of Marine and Fisheries of Canada, as to the British Columbia coast, and the U. S. Department of Commerce, as to Alaska, be asked to pass uniform legislation or promulgate uniform orders, that will regulate commercial trolling, and the landing of troll-caught fish, by the establishment of closed season periods.

SURVEY OF THE VIRGIN RIVER VALLEY AND THE BOULDER DAM

The Interior Department has published a report by the Geological Survey on an area that will be partly covered by the proposed reservoir on the Colorado River. Southeastern Nevada north of the big bend of the Colorado will be affected by the construction of the proposed Boulder Dam, because the Virgin River valley will be partly flooded by the impounded waters.

The valley of the Virgin lies between the Muddy Mountains on the west and the Virgin Mountains on the east, and all three features, which are parts of what is known as the "basin-range country," occupy territory immediately west of the great plateaus through which the Colorado River has cut its Grand Canyon. The Grand Wash Cliffs, east of the Virgin Mountains, form the boundary between the two regions.

Early scientists who traversed the Great Basin and the Colorado plateaus gave only passing notice to the Muddy and Virgin Mountains, so that until the last few years their geology has remained practically unknown. Nevertheless these mountains, which occupy critical border positions, should shed much light on the geologic history and relations of these two most interesting but very different types of country.

The report just published deals particularly with the Muddy Mountains and the Virgin Valley, but it includes some discussion of the Virgin Mountains and of a strip of country eastward to the Grand Wash Cliffs and is accompanied by a colored geologic map. The geologic formations described are in part identical with those exposed in the Grand Canyon, but they include other formations that throw additional light on the long and diversified geologic history which the canyon region has experienced.

In contrast with the fairly simple structural outlines of the plateau region, these mountains present folded and broken structure which indicates that the rocks had formerly been subjected to intense compressive forces. Later disturbances and prolonged erosion have combined to produce a highly complex and interesting sequence of surface features.

The report is designated Bulletin 798 and entitled "Geology of the Muddy Mountains, Nevada," by

Chester R. Longwell. Though of interest chiefly to geologists and physiographers, it contains much information about the Colorado River region adjacent to the proposed Boulder Dam site and supplies some sidelights useful to those who are following the Boulder Dam discussion.

THE INTERNATIONAL INSTITUTE OF AGRICULTURE

IT is stated in the London *Times* that the ninth general assembly of the International Institute of Agriculture, in its closing session at Geneva, voted a number of resolutions, strongly supported by the British and American delegations, tending to bring the institute more into line with modern ideas of the organization of international institutions. A resolution was passed "recommending that the meetings of the permanent committee should, as far as possible, take the form of quarterly sessions."

The provisional agreement reached between the League of Nations and the institute was also approved, and the permanent committee was invited to continue negotiations with the least possible delay with the object of reaching a definitive arrangement.

Resolutions were also passed on the subject of collaboration with the International Wine Office, on convening an international conference on meat, and on promoting the forthcoming world agricultural census. As regards the question of the institute's program of work, the assembly approved of the following amended text of the British delegation's proposal.

"That, having regard to the situation in which the institute finds itself owing to its restricted income, the main work of the institute shall be concentrated upon the preparation and presentation of (1) statistics of the world's agriculture, with such documentation and discussion as will render them of prime authority, and (2) economic reports and inquiries that may arise out of statistical works or throw light upon it; that, for the same reasons of economy, the scientific and technical work shall be directed principally to publishing reports on particular developments of importance to agriculture, to be obtained from competent authorities in any country."

ORGANIZATION IN THE DEPARTMENT OF AGRICULTURE

A NEW division, the Division of Soil Chemistry and Physics, has been formed in the Bureau of Chemistry and Soils, with Dr. Horace G. Byers, lately professor in charge of the department of chemistry of Cooper Union, New York City, as chief. The new division combines the bureau's divisions of soil chemistry and soil physics. The functions of the merged divisions were formerly quite distinct, but recent intensive studies of colloids and the newer development of soil science brought the work of the two units into close relations. Dr. Byers is a graduate of Westminster College, New Wilmington, Pennsylvania, and received a Ph.D. from the Johns Hopkins University. For some years he was professor of chemistry at the University of Washington. During the war he served as a captain in charge of the emergency unit of the pyrotechnic section of chemical warfare. In 1919 he entered the Department of Agriculture and was placed in charge of soil chemical investigations, but resigned to become head of the department of chemistry of Cooper Union.

Dr. Eugene C. Auchter, of the University of Maryland, was appointed principal horticulturist in charge of the newly created office of horticultural crops and diseases, to take office November 16. As principal horticulturist in the Bureau of Plant Industry, Dr. Auchter will assume general supervision not only of the vegetable gardening, pomological and related lines of the present office of horticulture, but also of the physiological project of the office of plant geography and physiology, as well as the work of the pathological laboratory and of the office of vegetable and forage diseases, and the entire office of fruit diseases and the office of crop physiology and breeding.

Grouping these related offices under one head, it is believed, will facilitate the cooperative research upon the many complicated problems of horticulture, not only among the specialists of the new organization, but also with the specialists of the state agricultural experiment stations and of the horticultural industries. The total budget for the new organization is approximately $1,000,000 annually.

A NATIONAL INSTITUTE OF HEALTH

LAST April the executive committee of the American Association for the Advancement of Science gave formal endorsement to the principles of the Ransdell bill now before the United States Senate. This bill contains three features: First, the creation of a National Institute of Health, which would replace the present Hygienic Laboratory of the United States Public Health Service and greatly enlarge its research activities; second, the establishment of a system of fellowships for the conduct of research, either in the Washington laboratories of the institute, or in universities or endowed institutions either in this country or abroad; third, authorization of the acceptance of "gifts by will or otherwise for study, investigation and research in the fundamental problems of the diseases of man and matters pertaining thereto."

Hearings were held on this bill before the Committee on Commerce on May 25, 1928, at which there

were offered resolutions of approval by many national scientific organizations, testimony was given by leading scientists, and letters of approval from men prominent in the scientific and industrial life of the nation were placed in the record.

In the light of these hearings, the Committee on Commerce reported "favorably thereon, with the recommendation that the bill do pass without amendment."

The bill is now on the regular calendar of the Senate, and will be brought up for action during the coming winter session.

The most interesting feature of the progress of this bill in the Senate has been the fact that throughout all the discussions and the hearings emphasis has been laid upon the need of *fundamental research*, and not a single objection was made by any member of the Senate to the fact that fundamental research was being sought. This is a new thought in connection with congressional appropriations for research. It may be that this in part represents more advanced average thinking by the nation on research; frankly, however, I believe Congress is ahead of the average thought of the nation in this matter. Certainly it portends better things for the future.

CHAS. H. HERTY

THE CHEMICAL FOUNDATION
NEW YORK CITY

SCIENTIFIC NOTES AND NEWS

IT is announced that the Nobel prize for medicine for 1928 has been awarded to Professor Charles Nicholle, the director of the Pasteur Institute in Tunis, in consideration of his work on typhus, more especially on the part played by lice in carrying the disease.

DR. WILLIAM S. THAYER, professor emeritus of medicine at the Johns Hopkins University, has received the degree of doctor *honoris causa* from the University of Paris.

AT the thirty-ninth annual meeting of the British Institution of Mining Engineers held in London on October 24, the president, Professor Henry Louis, presented the medal of the institution to Sir Henry Hall "in recognition of his long and distinguished services in the advancement of the science and technology of mining."

DR. WILLIAM C. WHITE, U. S. Public Health Service, has taken up his work as chairman of the division of medical sciences of the National Research Council for the ensuing year, succeeding Dr. Howard T. Karsner, of the school of medicine of Western Reserve University, Cleveland. The vice-chairman of the division is Dr. Ludvig Hektoen, of the University of Chicago.

DR. GANO DUNN, president of the J. G. White Engineering Corporation, of New York City, recently chairman of the National Research Council, has been elected twentieth alumni trustee of Columbia University to serve until 1934.

IN recognition of Professor Edward L. Rice's thirtieth year as a member of the faculty of Ohio Wesleyan University, thirty of his students in the field of botanical and zoological science have created an Edward L. Rice scholarship fund. A presentation of the fund to the university was made by Dr. Dwight M. DeLong, professor of zoology and entomology at the Ohio State University, at the chapel service on October 27, as a feature of the annual home-coming celebration. The fund will provide a scholarship each year for at least one advanced student, enabling him to do graduate summer-school laboratory work at one of the biological stations. Professor Rice went to Ohio Wesleyan as the head of the department of zoology in 1898. He is the son of Dr. William North Rice, three times acting president and now professor emeritus of geology at Wesleyan University.

DR. ROBERT A. LAMBERT, director of the School of Tropical Medicine in San Juan, Porto Rico, which is under the auspices of Columbia University, has resigned to accept a post as associate director of medical education with the Rockefeller Foundation. Dr. Earl B. McKinley, formerly a member of the staff of the International Health Division of the Rockefeller Foundation, has been appointed professor of bacteriology in the College of Physicians and Surgeons, Columbia University, and succeeds Dr. Lambert as director of the School of Tropical Medicine.

NORMAN R. BLATHERWICK, who for the past eight years has been biochemist and director of chemical research at the Potter Metabolic Clinic, Santa Barbara Cottage Hospital, California, has resigned to become director of the Biochemical Laboratory of the Metropolitan Life Insurance Company, New York, N. Y.

PROFESSOR JUSTIN S. DE LURY, head of the geological department of the University of Manitoba, has been appointed commissioner of mines for the province of Manitoba, in succession to Professor H. G. Wallace, who has recently been appointed president of the University of Alberta.

DR. FLORENCE BASCOM, professor of geology at Bryn Mawr College, having reached the age of retirement will continue her work at the U. S. Geological

Survey, Washington, D. C., where communications for her should be addressed. Dr. Charles S. Evans and Dr. Harland Billings will carry on the work in geology at Bryn Mawr College.

DR. JOHN H. GREGORY, of the Johns Hopkins University school of engineering, is employed by the Baltimore Public Improvement Commission as general consultant in matters pertaining to new $10,000,000 water improvement projects.

PROFESSOR FRED L. PLUMMER, of the Case School of Applied Science, has been retained by Wilbur Watson and associates to act as consultant together with Professor George E. Beggs, of Princeton University, on the design of the mammoth zeppelin to be built by the Goodyear Zeppelin Corporation of Akron, which was awarded the contract for the construction of the world's two largest zeppelins by the United States government. Professor Plummer was granted a leave of absence of one year from the Case School and for several months has been devoting his full time to the design of the proposed Lorain Central High Level Bridge. He will now divide his time between these two projects.

THE following names of associate editors of *Animal Breeding* should be added to the list given in SCIENCE on October 5; Dr. C. H. Eckles, College of Agriculture, University Farm, St. Paul, Minnesota; Dr. J. W. Gowen, Rockefeller Institute for Medical Research, Princeton, New Jersey; Dr. J. L. Lush, Texas Agricultural Experiment Station, College Station, Texas; Dr. H. C. McPhee, animal husbandry division, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C.

DR. WILLIAM R. MAXON, associate curator of plants, of the U. S. National Museum, returned recently from a three months' trip devoted to study of tropical American ferns in European herbaria. About two thirds of the time was spent in London examining type and other material of Jamaican ferns at the British Museum (Natural History) and the Royal Botanic Gardens, Kew. Short visits were also made to the botanical museums at Stockholm, Copenhagen and Berlin.

H. T. EDWARDS, technologist of the office of fiber plants, Bureau of Plant Industry, who has been in the Philippine Islands nearly a year carrying on work with abaca and other fiber plants in cooperation with the Philippine Bureau of Agriculture, returned to Washington on October 21.

DR. JAN B. JANSEN, professor of anatomy at Oslo, Norway, is spending a year in research at Boston University.

PROFESSOR FRANCIS R. FRASER, director of the medical unit of St. Bartholomew's Hospital, London, is visiting Australia at the invitation of the postgraduate committee of the British Medical Association in Australia. He will lecture on cardiology to the members in Melbourne and Sydney.

SIR SAMUEL SQUIRE SPRIGGE, London, editor of *The Lancet*, has been visiting universities in the United States and Canada and will make a report on his return to England on medical education in the United States.

DR. GEORGE H. CRESSE, professor of mathematics in the University of Arizona, who has recently returned from a year's study at the University of Göttingen, delivered the annual liberal arts lecture on November 8, his subject being "Higher Education in Germany and America."

DR. C. E. K. MEES, director of the research laboratory of the Eastman Kodak Company, lectured before the Franklin Institute on October 25, on "Amateur Cinematography and the Kodacolor Process." He will give a lecture on "Kodacolor" in the American Museum of Natural History, New York City, on November 12, at 8:15 in the evening.

DR. SELIG HECHT, professor of biophysics at Columbia University, gave on November 3 a lecture on "The Nature of the Sensitivity of Animals to Light," at a special joint meeting of the Philosophical Society of Washington and the Biological Society of Washington, arranged through cooperation with the Optical Society of America.

PROFESSOR HARLAN T. STETSON, of the Harvard College Observatory, lectured on "What of the Sun Spots?" before the Amateur Astronomers Association at the American Museum of Natural History, New York City, on October 17.

DR. P. W. WHITING gave a lecture on "Some Recent Experiments in Heredity" and Dr. Elmer Hutchisson gave a lecture on "New Styles in Atoms" at a meeting of the Sigma Xi Alumni Association of the University of Pittsburgh on October 23.

DR. EDWIN O. JORDAN, professor of bacteriology and chairman of the department of hygiene and bacteriology in the University of Chicago, has been appointed Cutter lecturer in preventive medicine at Harvard University for the year 1928–29.

THE Harveian oration before the Royal College of Physicians of London was delivered on October 18 by Sir Humphry Rolleston, regius professor of physics in the University of Cambridge, who took as his subject "Cardio-vascular Disease since Harvey's day."

DR. J. A. GLOVER, of the British Ministry of Health, has been appointed by the Royal College of Physicians Milroy lecturer for 1930.

SIR JAMES JEANS, secretary of the Royal Society, who from 1905 to 1909 was professor of applied mathematics at Princeton University, delivered on October 30 the first Henry Herbert Wills Memorial Lecture, founded to commemorate the gift of the Physical Laboratory to the University of Bristol. The title of his lecture was "The Physics of the Universe."

A TABLET in memory of Charles Martin Hall has been unveiled in the house at Oberlin in which he invented the electrolytic process for the manufacture of aluminum in 1886, a year after he graduated from the college. In 1914 Hall willed to Oberlin College one third of his estate, a bequest which now amounts to about $10,000,000.

As has already been noted in SCIENCE a monument in memory of Pasteur has been unveiled in Grant Park, Chicago, near the Field Museum. The monument consists of a marble shaft twenty feet high surmounted by a bust of Pasteur. The speakers on the occasion of the dedication were: The French ambassador, Paul Claudel, Vice-President Charles G. Dawes, Dr. Frank Billings, chairman of the memorial committee, and Dr. Ludvig Hektoen.

A memorial meeting in honor of the late Dr. Hideyo Noguchi will be held in Cincinnati on November 18, sponsored by a committee representing the Academy of Medicine, the University of Cincinnati College of Medicine and the Public Health Federation. The principal address will be given by Dr. Frank Billings, of Chicago.

RICHARD L. HUMPHREY, distinguished for his work in mechanical engineering, chairman of the Pennsylvania State Board for the registry of professional engineers and surveyors, died on November 3.

DR. ALBERT SCHNEIDER, associate dean of the school of pharmacy of the North Pacific College of Oregon, died suddenly on October 27 at the age of sixty-five years.

DR. GEORGE HARTLEY BRYAN, F.R.S., died at Bordighera on October 13 at the age of sixty-four years. Dr. Bryan was an authority on thermodynamics and aeronautics. For many years he was professor of pure and applied mathematics in the University College of North Wales, Bangor, resigning the chair in 1926.

THE eighth annual meeting of the Highway Research Board will be held December 13 and 14, 1928, at the National Academy of Sciences and National Research Council Building, B and 21st Streets, Washington, D. C. The meeting will cover two days, with the annual Highway Research dinner on the evening of December 13.

THE League Health Committee, on which Great Britain is represented by Sir George Buchanan and Colonel J. D. Graham, Australia by Dr. J. H. L. Cumpston, and the United States by Surgeon-General H. S. Cumming, Dr. Alice Hamilton and Dr. C. E. A. Winslow, which began its thirteenth session at Geneva on October 25, adopted the report of the League Malarial Commission, which lays emphasis upon the necessity of each government establishing a central permanent organization composed of selected workers who will devote their whole time to malarial research, and suggests certain general rules to be followed in choosing and applying methods for combating malaria in any particular area. The committee discussed the question of collaboration with Latin America. It was stated that the investigation into infant mortality that was taking place in certain Latin-American countries had progressed most satisfactorily, and would probably be finished some time next summer.

A SOCIETY of applied physics has been organized in Akron, Ohio, with Professor F. F. Householder, of Akron Municipal University, as first president. The purposes expressed in the constitution adopted by the Akron Society of Applied Physics are: "To contact broadly, socially and professionally, technically and intellectually with fellows in physics and with those interested in physics in educational and in industrial institutions, and elsewhere; to maintain and create interest in and for current events in the history, the development and the application of physics; to encourage and aid in the application of physics to and in industry and other fields of science and of social welfare, and to encourage and aid educational centers to fit men better for industrial and tutorial work in physics and its applications." It is hoped by those who are concerned in the organization of this local society that there may eventually evolve a National Society of Applied Physics, similar to the German Society of Technical Physics. Such a society, it is expected, will interest and attract a large number of technical workers in physics and in related lines that are scattered throughout the industries.

LECTURES at the Franklin Institute at Philadelphia are scheduled as follows: October 17, Dr. Howard McClenahan, secretary, The Franklin Institute, "Plans for the Development of the New Museum and Other Activities of the Institute." October 25, Dr.

C. E. K. Mees, director, Research Laboratory, Eastman Kodak Company, "The Kodacolor Process." November 8, Gustaf W. Elmen, Research Department, Bell Telephone Laboratories, New York City, "Magnetic Alloys of Iron, Nickel and Cobalt." November 15, Dr. Geo. E. Uhlenbeck, University of Leiden, Holland, "The Ideal Gas in Modern Physics." November 21, Hiram B. Ely, captain, Ordnance Department, Frankford Arsenal, "Detection of Aeroplanes." December 6, Professor Vladimir Karapetoff, Cornell University, "The Development of a Five-stringed 'Cello, with Demonstrations." December 13, Dr. Philips Thomas, research engineer, Westinghouse Electric and Manufacturing Company, "By-products of Radio." December 19, Dr. Hermann Joseph Muller, University of Texas, "Mutations by X-Rays."

THE Fourth Pan-Pacific Science Congress will be held in Batavia, Java, from May 16 to May 25, 1929, under the auspices of the Netherlands Indies Pacific Research Committee and supported by the patronage of the Netherlands Indies government. The Bureau of Education reports that all branches of the physical and biological sciences bearing on tropical life and conditions will be discussed at the congress; and excursions will be projected to various places of industrial, scientific and historical interest in the islands. Representative organizations which have been invited to cooperate in the congress are specially requested to send as early as possible to the First General Secretary, Fourth Pacific Science Congress, Buitenzork (Java), Netherlands Indies, the following data: (a) The names, titles, professions and addresses of the delegates of their country, dominion, colony, territory or dependency; (b) the titles of the contributions they intend to present to the congress; (c) any special wishes concerning the organization meetings, scientific programs or excursions, and (d) the names of those who prefer hotel accommodation to hospitality in the homes of local residents. The congresses were inaugurated at Honolulu, Hawaii, in 1920, and subsequent meetings have been held in Australia and in Japan.

THE Lamont Astronomical Expedition of the University of Michigan completed the erection of its observatory at Bloemfontein, South Africa, and the installation of its 27-inch refracting telescope in the spring of this year. Regular observations for the discovery and remeasurement of double stars in the southern skies have been in progress since May 9. The number of discoveries up to September 1 last was 312 with many remeasured known doubles. The expedition is being directed by Professor R. H. Curtiss, director of the University of Michigan Observatory. The staff in Africa includes Dr. R. A. Rossiter, chief observer in immediate charge, M. K. Jessup and H. F. Donner.

UNIVERSITY AND EDUCATIONAL NOTES

IN compromise settlement of its suit against the Texan oil corporations, involving excess charges for gathering oil from wells upon land owned by the University of Texas in Reagan County, that institution has received a refund of $1,000,000. The money was deposited to the credit of the permanent fund, increasing it to approximately $11,000,000. This amount, with the exception of the $1,000,000, was received as royalties on oil production upon university lands. Payments are still being received at the rate of more than $150,000 a month.

DR. CHARLES G. CROOKS, for twenty-eight years professor of mathematics in Centre College and for a number of years dean of the college, has retired as dean emeritus because of ill health. He is succeeded as dean by Dr. Frank L. Rainey, professor of biology since 1908.

AT the University of Virginia, Dr. Robert E. Lutz has been appointed associate professor of organic chemistry, Dr. Lyndon F. Small research associate in organic chemistry and Mr. Lauren B. Hitchcock associate professor of chemical engineering.

DR. LAWRENCE WELD SMITH has resigned as assistant professor of pathology at the Harvard Medical School.

IN the Canadian letter of *Industrial and Engineering Chemistry* by S. J. Cook it is reported that several changes have been made in the staff of the department of biology at McGill University. J. B. Collip, formerly professor of biochemistry at the University of Alberta and a graduate of the University of Toronto, is now in charge of the department of biochemistry. He will be assisted by David L. Thompson, of Cambridge University, England, and R. L. Kutz. B. P. Babkin, formerly of Dalhousie University, has been appointed research professor of physiology in the department of physiology and experimental medicine, headed by Professor John Tait. Dr. Babkin received his university training in Russia. C. E. L. Morrow has been appointed demonstrator in this department. Ethel Simpson (Cornell University), holding a National Medical Research fellowship, is working with Dr. Tait on thyroid problems.

DISCUSSION AND CORRESPONDENCE

EXPERIMENTAL CONFIRMATION FOR SOMMERFELD-FERMI-DIRAC DEGENERATE GAS THEORY OF CONDUCTION ELECTRONS

SOME preliminary results of a study of the Compton modified line structure at this institute confirm the Sommerfeld theory of conduction electrons in metal crystal lattices.

This theory based on the Fermi-Dirac theory and the Pauli exclusion principle predicts a much broader range of velocities for the conduction electrons than is to be expected on the classical kinetic theory. A very appreciable proportion of the conduction electrons in this theory should indeed have speeds considerably exceeding the orbital speeds of the outer electrons in isolated atoms of the same metal. This is a result of the application to the conduction electron gas of the Pauli exclusion principle originally conceived to apply to electrons in single atoms. According to this principle the phase space is to be divided into cells of volume h^3 in each of which the presence of one electron precludes the entrance of any other electron. In other words for a one dimensional case the fact of an electron possessing a velocity, v, prevents neighboring electrons from possessing any adjacent velocity, the range of exclusion in velocity being inversely proportional to the separation in space of the electrons. For a completely degenerate gas (*i.e.*, one in which all the lowest phase cells are filled with electrons) it is evident that even at low temperatures this exclusion principle requires high velocities for some of the electrons. The electrons are uniformly distributed as to velocities up to a maximum velocity beyond which there are no electrons if one neglects a slight shading at this velocity boundary due to temperature. This critical velocity boundary is shown by Sommerfeld to be proportional to the cube root of the electron density in space.

The breadth and structure of the Compton modified scattered X-ray line is intimately connected with the speeds of the electrons which scatter the X-radiation in much the same way as the Doppler broadening of optical lines. A line structure can be computed for any given distribution of electron velocities. It has been found in the interpretation of our experimental results that a line structure computed on the basis of the above-mentioned Fermi-Sommerfeld theory accords with the experimentally found line structure much better than one computed on the assumptions either that the conduction electrons have classical thermal equipartition of energy or that they have the velocities they should have in the external orbits of free atoms far removed from neighboring atoms. Aluminium and beryllium have been studied, the results being most striking in the case of beryllium, where probably two out of the total of four electrons per atom are in the above-mentioned degenerate gas state.

JESSE W. M. DUMOND
NORMAN BRIDGE LABORATORY OF PHYSICS,
CALIFORNIA INSTITUTE

A READILY DETECTABLE SIGN OF OVULATION IN THE MONKEY

IT appears certain from the work of Corner[1] that a female monkey may menstruate with or without ovulating. There are, therefore, two types of menstruation: namely, one that is preceded by ovulation, the formation of a corpus luteum, and the building up of a typical "premenstrual" endometrium; and the second type (which R. Schröder wishes to designate as "pseudomenstruation") consisting of a similar periodic bleeding not preceded by ovulation or corpus luteum formation and issuing from a uterus in the resting stage. Hitherto it has been possible to differentiate between these two types only by removal of the organs and studying them histologically or by inspection of the ovaries and uterus during laparotomy.

A sign of ovulation, readily applied to the living intact animal would, therefore, be welcome—not only for differentiating the two types of menstruation and furthering the study of menstrual phenomena in other ways, but also for aid in securing timed embryological material. Such a test we believe we have found in the recovery of small numbers of red blood cells in lavages or douches made from the monkey vagina after a technique described in April, 1928.[2] The procedure consists of washing out the vagina with a pipette containing a standard quantity of physiological salt solution, diluting the lavage with six times the quantity of 1:12,000 methylene blue made up in salt solution instead of distilled water, and studying this final mixture in a blood-counting chamber under the microscope. The observations upon which this new sign of ovulation is based are the following:

For some time it was noticed that on the day after copulation in certain animals, when the vagina of the mated female was examined for spermatozoa, a few red blood cells were found among several thousand cornified cells and leucocytes recovered from the lumen of the vagina. The number of red blood cells thus recoverable are so few that they would never be discovered in smear preparations made in the usual way.

[1] Geo. W. Corner, 1923, *Contrib. to Embryol.*, Vol. 15; also 1927, *Jour. Am. Med. Assn.*, 89: 1838–40.

[2] Carl G. Hartman, 1928, *Am. Jour. Obst. and Gyn.*, 38: 61–71.

This blood was at first interpreted as due to slight trauma arising from the act of copulation. However, this explanation soon appeared faulty, since the trace of blood was sometimes found in the largest females mated to a smaller male or was absent from small females mated to a larger male. Again, the blood would be absent from a given female soon after mating and appear one or two days later. Since, finally, the erythrocytes were consistently absent in the early and late interval, present only between the eleventh and the eighteenth day of the cycle, another explanation had to be sought. The blood could hardly originate, as in dogs and cows in proœstrum, from a congested uterus, since the red blood cells were recovered only for a very short time—one or two or at the outside three days—whereas the premenstrual congestion increases progressively towards the succeeding menses. This leaves only one other important event occurring in the interval, namely ovulation.

Of twenty mature females menstruating regularly, ten showed the ovulatory bleeding during the past month. Two animals showed the sign on the eleventh day of the cycle; one of these also on the thirteenth day. Four females had a few red cells in the specimen on the twelfth day and of these one also on the fourteenth day. Three females gave the positive test on the sixteenth day and one other on the eighteenth day. Examination of the animals was made only every other day; hence it is possible that some of the other females belonged really to the ovulating class.

Theoretically the explanation here given for the appearance of slight traces of blood in the mid-interval is logical, for during ovulation there is always a hemorrhage, variable in extent though usually slight. While minute in volume, this blood may nevertheless contain millions of red blood cells, which, if distributed through the tube, uterus and vagina, should be recoverable from the vagina by an appropriate method.

To put the theory to a test, laparotomies were performed on two females (Nos. 39 and 43), both of which, judging by their brilliant sex color, the drop in leucocyte count, and the favorableness of the time in the menstrual cycle, gave equal promise of ovulation and fertile mating. Both were mated during the night of Oct. 1–2, No. 39 on the 10–11th day of the cycle, No. 43 on the 12–13th day. Active spermatozoa were recovered in both cases on Oct. 2, a few red blood cells in the case of No. 43, none in the case of No. 39. The former showed a few red blood cells also on Oct. 4, the latter none at any time. Laparotomies done on the afternoon of Oct. 4 disclosed a young corpus luteum in No. 43 that had shown the sign and no corpus luteum but only a small atretic follicle in the case of No. 39 in which the ovulatory sign had been absent.

That the test will be found to apply to women is entirely reasonable; the matter is therefore being studied in the human species also. It need scarcely be pointed out that the method may prove of use in the diagnosis of causes of sterility; for a positive test is at once a proof of ovulation and of the patency of the fallopian tubes.

CARL G. HARTMAN
DEPARTMENT OF EMBRYOLOGY,
CARNEGIE INSTITUTION OF WASHINGTON,
BALTIMORE, MD.

OCCURRENCE OF FAINT BLEEDING ON A DEFINITE INTERMENSTRUAL DAY IN MAN

KNOWING that we were at work on a study of the vaginal smear in man, notice of the preceding article by Professor Hartman was sent one of us (H. M. E.) in a personal letter under date of October 23, 1928, and prompts the following note.

We have only occasionally observed the occurrence of even slight numbers of erythrocytes in the human vaginal smear or any intermenstrual day, but one patient in whom for a year of careful study this was not seen has subsequently for almost two years exhibited with great regularity the phenomenon of sharply circumscribed faint bleeding on a definite day of the intermenstruum. The case (G. P. B., aet. 32, a graduate student at this institution) is that of an individual in excellent vigor and health save for the unexplained sudden incidence of a slight leucorrhea lasting the particular twenty months during which time the bleeding noted was detected. Coincident with the finding of traces of brownish blood on this particular day there was always an increase in quantity and in the irritating character of the vaginal secretion. The phenomenon was limited to two days at most and usually characterized a single day of the intermenstruum and occurred at times in different cycles varying between day fifteen and day nineteen of the period.

It remains, of course, to be seen whether in this exaggerated case we have had the fortune to detect for the first time in man an occurrence almost certain to be overlooked if extraordinary care to detect it be not exercised. Even in the case here noted, only the early morning lochia were blood-tinged (brown), and we would consequently emphasize the value of examinations made immediately on rising if the transitory sign is to be found.

MIRIAM E. SIMPSON,
HERBERT M. EVANS
UNIVERSITY OF CALIFORNIA,
OCTOBER 30, 1928

INTRAMUSCULAR INJECTIONS ANATOMICALLY CONSIDERED[1]

MANY studies of the injection of medicinal substances into the muscle masses of the human body have been made, but, for the most part, they have considered the avoidance of vessels and nerves and the rate of absorption of the introduced substances.

In our study we have concerned ourselves primarily with the relation of the immediate distribution of the substance injected to the structure of the muscle and its associated connective tissues. For our study we used cadavera selected from the anatomical material received by the University of Cincinnati during the past two years. The intramuscular injections were made into both fresh and preserved cadavera. We have examined dissections, frozen sections and roentgenograms. For injection material we have used aqueous dye solutions, colored mineral oil, vegetable oils, varnish solutions and pharmaceutical preparations, such as iodized oil, brominized oil and grey oil. We have found no essential differences in the behavior of any of the above upon injection.

In every case, *no matter what the direction of the injecting needle,* the introduced solution traveled in the direction of the muscle fibers. Large quantities of injected material and great pressures tended to obscure but did not obliterate the pattern. In muscles with large fasciculi and heavy intramuscular septa the picture is very evident. In the gluteus maximus the injected mass spread to the dependent portion along the muscle fibers. In the usual prone position of the cadaver this is lateralward and in the general direction of the trochanter major.

In other words: the distribution of substances introduced by intramuscular injection takes place along the lines of least resistance. It differs in no wise from the spread of pyogenic material along muscle fasciculi and in fascial compartments—an occurrence which is so well known from numerous studies made on the forearm.

As a *practical* conclusion of our investigation we would recommend that intramuscular injections be made with the shaft of the needle parallel with the general direction of the muscle fibers and with the point directed downward, *i.e.,* towards the dependent portion. In the case of the muscles which are frequently selected (deltoid, triceps, gluteus maximus) our recommendations automatically secure the avoidance of large vessels and nerves.

KARL G. ZWICK
O. V. BATSON

DEPARTMENT OF ANATOMY,
UNIVERSITY OF CINCINNATI

[1] Preliminary note.

NOMENCLATORIAL STATUS OF THE AMEBAS MAYORELLA BIGEMMA AND M. (?) DOFLEINI

THE two species of amebas mentioned in the title of this note are stated to be synonymous by Johnson.[1] The cause of this synonymy he apparently presumes arose out of my having overlooked the paper in which the author (Neresheimer) of *dofleini* described this species when I published my description of *bigemma.* I did not overlook the paper in question but read it carefully before I published my description of *bigemma* and again now. I did not quote the paper because the species *dofleini* described therein did not seem sufficiently closely related to *bigemma* to warrant it. The chief reasons for regarding these two species as differing from each other specifically in a thoroughgoing manner are set forth in a brief article in a forthcoming number of *The American Naturalist.*

A. A. SCHAEFFER

UNIVERSITY OF KANSAS

HUMIDITY AND SONG

PROFESSOR VUILLEMIER'S jocular note in SCIENCE for June 15 may have more truth than the general reader realizes. I have long observed that there is a definite relation between the frequency of song of the western meadowlark (*Sturnella neglecta*) and the humidity of the air. This meadowlark sings most frequently when the air has a relatively high humidity. Its song is much less frequent in the arid summer season than in the winter. The bird is heard at Riverside most frequently in winter just before or after a rain and sings readily in cloudy, misty weather. Dr. Ritter[1] mentions that the song of this bird is heard in the moist littoral region at La Jolla every month in the year, and that its frequency is greatest in the morning and evening.

There seem to be good reasons for believing that the singing of the western meadowlark is conditional upon the moisture content of the air.

H. S. REED

CITRUS EXPERIMENT STATION,
RIVERSIDE, CALIFORNIA

QUOTATIONS

TRAVELING EXPENSES AND THE INCOME TAX

TRAVELING expenses incurred by physicians in attending meetings of medical associations are deductible in the computation of their federal income taxes. The Commissioner of Internal Revenue has erred in

[1] SCIENCE, July 27, 1928, p. 84.
[1] "The Unity of the Organism," p. 260, Vol. 2.

denying the deductibility of such expenses. The Board of Tax Appeals made this decision, October 2, in passing on the appeal of Dr. Cecil M. Jack, of Decatur, Illinois.[2] The decision becomes final at the expiration of six months from its promulgation unless an appeal is taken to the courts before that time. The commissioner did not appeal, however, when the Board of Tax Appeals rendered similar decisions against him in favor of ministers[3] and of chemists,[4] in cases identical in every essential circumstance with the present case. In those decisions the commissioner officially acquiesced, without waiting for six months to expire, and there seems to be no reason why he should follow a different course now. Acquiescence seems more probable, too, since the board, in promulgating its decision in the present case, cited as precedents the very cases in which the commissioner had acquiesced, and repudiated as a precedent a decision of the board[5] by which the commissioner undertook to justify his course. In that case, the board pointed out, it was necessary for the board to uphold the commissioner's denial of the physician's claim of the right to deduct traveling expenses, because the physician had not submitted proofs of the amounts expended. The only discoverable result that would follow an appeal by the commissioner is added expense and trouble to the taxpayer and to the government, an additional case to clog the court calendar, and, pending a decision by the court, many thousands of payments unlawfully exacted of physicians under the guise of taxation, to be added to the tens of thousands of such payments already exacted, all of which the government may be called on to refund.

Since the Commissioner of Internal Revenue first denied to physicians their right to deduct traveling expenses, in 1922, the medical profession has paid probably as much as a half million dollars into the treasury, to avoid unlawful demands by the commissioner, the distraint of property and suits. Subject to certain limitations on the time within which claims for refunds must be filed, all of this money will be repayable to the physician who paid it, if the courts are not called on within six months to reverse the decision of the Board of Tax Appeals and if on appeal they sustain the decision of the board.

Applications for refunds may be filed without waiting for any further official action in the case. Claims for refunds for the tax years 1924 and 1925 must be made within four years from the date of payment; for the tax years 1926 and 1927, within three years, and for the tax year 1928, within two years. Unfortunately, in many individual cases the amounts repayable are probably so small that the physician will not feel justified in going to the trouble and expense of making a claim, and in many cases it will be difficult at this late date to produce adequate legal proof of the exact amounts paid for railroad fares, Pullman accommodations, hotel accommodations, meals and other allowable expenses. Applications for refunds must be made on the special form provided for that purpose,[6] copies of which can be obtained from the local collector of internal revenue. A separate application must be made for each year for which a refund is claimed. Every application must show that it is based on the decision of the Board of Tax Appeals in Jack *vs.* Commissioner of Internal Revenue.[7] Applications must be filed with the collector of internal revenue within whose district the refundable money was paid.—*Journal of the American Medical Association.*

[2] Appeal of Cecil M. Jack, Docket numbers 14995 and 17662, decided, Oct. 2, 1928.

[3] Appeal of Marion D. Shutter, 2 B. T. A. 23.

[4] Appeal of Alexander Silverman, 6 B. T. A. 1328.

[5] Appeal of Everett S. Lain, 3 B. T. A. 1157.

[6] Internal Revenue Service, Form 843.

[7] Appeal of Cecil M. Jack, Docket numbers 14995 and 17662, promulgated, Oct. 2, 1928.

SCIENTIFIC BOOKS

Animal Ecology. By CHARLES ELTON. New York. The Macmillan Company, 1927. Pp. xx, 207, pls. I–VIII, diagrams in text 1–13.

To out-of-doors biologists Elton's book should make a strong appeal. The author makes the point that the discoveries of Darwin, who was a magnificent field naturalist, had the remarkable effect of driving the scientists indoors, where they remained hard at work for fifty years or more "and whence they are now beginning to put cautious heads again into the open air." It is unfortunate, as Elton says, that almost a third of zoology has been so sadly neglected. The present work ought to do much to interest students in this neglected third—ecology—which, as Elton says, is simply another name for scientific natural history.

The author explains he has laid a good deal of emphasis on practical bearings, partly because many of the best observations are made by economic workers, "partly because the principles of animal ecology are seldom if ever mentioned in zoological courses in the universities, in spite of the fact that it is just such knowledge which is required by any one who is brought up against practical problems in the field, after he leaves the university."

One of the difficulties in ecology has been and is the lack of clearly conceived coordinating principles. The employment, in plant ecology, of "succession," "dominance," "reaction" and other concepts has been very

helpful. Elton stresses additional coordinating principles which ought to be useful not only in animal assemblages but also with biotic communities. The animal community, he says, can be best understood on a food-chain, food-cycle basis. Each animal can ingest food of a certain range of size only. This results in a gradation of eaten and eater from small, even microscopic, forms at one end of the food chain through larger and larger species to the largest at the other end of the chain—usually a carnivore. Elton emphasizes the significance of the study of *niches,* too, meaning by the term the status of the animal in the community, principally in relation to food, enemies and activities. The importance of "ecologic niches" has long been recognized in this country, especially by Grinnell[1] and certain of his coworkers, though not cited in this connection by Elton.

Elton believes that in the future at least half of all work in animal ecology will be concerned with the numbers of animals. As he points out, the numbers of animals, their fluctuations and regulation, are all-important in economic considerations. Closely linked with the food-chain, food-cycle, size of food, and niche, is what Elton calls the pyramid of numbers. By this rather telling figure he stresses the fact that the small "key-industry" animals at the base of the food-chain are exceedingly abundant, while the successively larger animals become less and less numerous. Variations in numbers with season, climate and cycle come in for discussion, and reference is made to plagues of mice and lemmings. If the accounts of and references to mouse plagues in the literature generally are as much exaggerated as is Julian Huxley's allusion to the California mouse plague of January–February, 1927, in the introduction to Elton's book (p. xvi), one should discount them considerably if he wishes to view them in proper perspective. This is probably not Huxley's fault, except as he used the lurid pseudo-scientific accounts of the occurrence that apparently went all over this country and crossed the ocean. In this same introduction Huxley attributes the subsidence of rodent plagues to the outbreak of some epidemic, and suggests that the killing of the rodents by man either has no effect on the natural course of events or even delays the crisis and maintains the rodent plague longer than would otherwise be the case. But it seems clear that natural epidemics can not possibly and should not be relied on to regulate the numbers of noxious rodents. Wherever a disease transmissible to live-stock and human beings is involved (as in the California mouse plague cited) such a course would often be dangerous to the public health. Omission to provide for effective control, as in the case of rabbits in the southwestern United States, in England, Australia and elsewhere, has apparently not resulted in effective natural control. Admittedly our regulation of animal populations is, at this stage, highly empiric and faltering; but Huxley's suggestion does not help much. On the other hand Elton and Huxley are probably correct in stating (p. xiv) that the existence of enemies is in a majority of cases a biological necessity to a species, "which without them would commit suicide by eating out its food-supply."

The scope of Elton's book is indicated by the chapter headings, which include "The Distribution of Animal Communities," "Ecological Succession," "Environmental Factors," "The Animal Community," "Parasites," "Time and Animal Communities," "The Numbers of Animals," "Variations in the Numbers of Animals," "Dispersal," "Ecological Methods," "Ecology and Evolution."

In spite of Elton's assertion that "plant ecologists can not afford to ignore animals, while a knowledge of plant succession is essential for animal ecologists" (page 18) he seems to miss the essential unity of the plant-animal community. While it is true that special methods must be developed and applied in animal ecology, nevertheless, an adequate solution of ecological problems can only be attained through attention to the biotic community and not animals or plants alone.

In his assertion that " . . . habits and habitats of animals may form systematic characters quite as important as structural features. . . ." the author strikes a sympathetic chord in the reviewer, who made a similar suggestion in a paper published thirteen years ago.[2]

With Elton's contention that "Ecology is a branch of zoology which is perhaps more able to offer immediate practical help to mankind than any of the others" the reviewer is also in complete agreement.

Elton's work is suggestive and stimulating. The author is to be congratulated on it.

WALTER P. TAYLOR

Les Bases Physiologiques de la Fécondation et de la Parthénogénès. By ALBERT DALCQ, Chargé de Cours at the University of Brussels, with a preface by Professor A. Brachet. Volume XI of the collection, "Les Problemes Biologiques," Les Presses Universitaires de France, 1928. 274 pages.

[1] See Grinnell, *Univ. Calif. Publ. Zool.,* 12(4): 91, March 20, 1914, and Taylor, *Univ. Calif. Publ. Zool.,* 12(15): 473–482, March 20, 1916.

[2] *Proc. Calif. Acad. Sci.,* 4th ser., 5(5): 116–117, December 30, 1915.

THIS book, while professing by title to deal with the general question of fertilization and parthenogenesis, is concerned with a greater field. It might better perhaps be spoken of as a critique of the elementary phenomena of development, notably the events of fertilization and first cleavage. The author is personally familiar with this subject, having done a great deal of original work in the field himself. In spite of this the presentation of the material and the interpretation given by the various investigators is to a large degree unprejudiced by the author's own researches.

While one might expect that the early chapters would be devoted primarily to the interpretation of the phenomena of the fertilization, the physiology of the gametes, et cetera, the author considers first what he terms the physiology of segmentation. A clear presentation follows not only of the numerous theories of cell division but also of the initial period in cell division which precedes first cleavage and follows fertilization itself. In this part of the book, as in the chapters which follow, the author deals with not only the evidence derived from physical and chemical methods of investigation, but also that from cytology. Here, as has been mentioned above, the author's first-hand knowledge of the material makes the review decidedly valuable.

A special chapter is devoted to the events which take place between the time of activation and segmentation. Here Dalcq considers not only the events of normal fertilization, viz., the cortical and internal changes in the egg, the migration of the pronuclei, etc., but also the questions of polyspermy and parthenogenesis. The author seems to distinguish between fertilization and activation, a consideration of which follows.

One can not but feel that the chapter on activation is too brief, though some of the discussions which might be looked for here appear in the final chapter of the book. The author presents here a table which contains a summary of the agents and forms used in experiments on artificial parthenogenesis, which is very useful. The cytological pictures presented accompanying and following activation are treated in a separate chapter, as are also what the author terms the purely physiological results of activation. In one of the later chapters of the book which is devoted to the maturation of the gametes, Professor Dalcq has attempted the correlation of the cytological data with the evidence obtained by other methods. The author concludes the book with a chapter on the meaning of activation, in which he gives briefly the various theories which have been presented to explain the phenomena of fertilization.

Not since the publication of "The Problems of Fertilization" by F. R. Lillie has there appeared a book devoted to this subject. The actual space in the present volume concerned with the fertilization question is not as great as the title would lead one to expect. This fault is, I believe, a fortunate one, for while a great deal has been done on the fertilization reaction in the interim, the phenomena involved are so intimately connected with the events preparatory to the first cleavage that the two are difficult to separate and find themselves easily associated in the same book. The analysis of the material is fairly complete, though some aspects have been treated in a rather brief manner.

Unfortunately, a few errors in the names of scientific investigators (which it is to be hoped will be eliminated in the next edition), have crept into both text and bibliography.

The book has a great many figures and tables, some of the latter being taken from original works while others have been compiled in a most useful way by the author. The book has appended a bibliographical list of some thousand titles. Unfortunately, as is the case with other volumes of this series, there is no index.

LEIGH HOADLEY

ZOOLOGY DEPARTMENT,
HARVARD UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE DETERMINATION OF NITRATES AND NITROGEN

IN determining nitrates in highly organic soils by the ordinary method of shaking with some material such as cupric hydroxide, which takes out the color by absorption and occlusion, considerable variation occurred in checks, probably due to interfering substances and the occlusion of nitrates. In determining total nitrogen a fresh sample was required. It was also found that the regular Kjeldahl method was burdensome where the digestion was excessively long, as is the case on most samples high in organic matter. This is especially true of samples of plant tissues.

The idea of distilling off the nitrate nitrogen from a concentrated sulfuric acid solution into an oxidizing solution and catching the other nitrogen as ammonium sulfate, which then could be oxidized to nitric acid and distilled off suggested itself. In order to do this it is necessary to destroy the organic matter and keep the nitrogen oxidized to the high valency state without decomposition during distillation. Chloric acid

is very vigorous in destroying organic matter and sodium chlorate was chosen as the oxidizing agent. As a result of tests on several entirely different samples it was found that the nitrates did not vary greatly between checks and ran slightly higher than by the ordinary method and that the total nitrogen checked well with the regular Kjeldahl method, taking much less time. At the same time a clear solution of the inorganic elements, contaminated only by sodium sulfate and sulfuric acid, was obtained, the hydrochloric acid formed being decomposed to free chlorine and driven off.

Procedure for Nitrate Nitrogen

The sample should be air dry and ground to pass at least a twenty-mesh sieve. Place one gram of plant or animal tissue or ten grams of mineral soils into a dry five hundred cc Kjeldahl flask. Add twenty-five cc of cold 75 per cent. sulfuric acid and connect to an ordinary glass-water-cooled condenser by means of a glass-tube connection so that some air cooling takes place. Extend the tube several inches through the rubber stoppers used, in order to prevent fumes from readily acting on the rubber.

Catch the distillate in a five hundred cc Erlenmeyer flask containing fifty cc of a chlorine dioxide solution. This is prepared by bubbling chlorine dioxide from a generator into water until the water takes on a bright yellow color and green fumes form above the surface. The chlorine dioxide is generated by dropping concentrated hydrochloric acid on about fifteen to twenty grams of potassium chlorate in twenty-five cc cold water. The chlorine dioxide should pass through glass as it oxidizes rubber. The generator must be kept cold and not too much hydrochloric acid added at once. Warming to 70° or above may cause an explosion. With ordinary amounts of hydrochloric acid, however, the explosion usually does no harm.

The gases given off from the digestion mixture are made to bubble through the chlorine dioxide solution by means of a bent glass rod connected to the condenser and inserted in the yellow liquid in the tilted Erlenmeyer. At the same time chlorine dioxide gas is bubbled through the solution by means of another bent glass rod from the generator. The chlorine dioxide should be bubbled in fast enough to keep the solution yellow and greenish fumes in the air above the solution.

Gradually heat the sample, regulating the flame so that too rapid bubbling does not occur. Care should be taken not to let the solution draw back by suddenly lowering or withdrawing the flame. Distil until all water is over and the sides of the Kjeldahl begin to be washed down by the condensing of sulfuric acid fumes (five to fifteen minutes). Disconnect the flask. Set aside the residue to cool for the determination of nitrogen other than nitrate nitrogen. Wash out the condenser several times with a wash bottle into the distillate.

Boil the distillate until it has remained colorless a few minutes. Add a bit of litmus and just neutralize with strong sodium hydroxide. Push the litmus, which should be blue, to the top of the flask with a glass rod. Hold the litmus with the rod and wash them both with water. Remove the litmus. Evaporate the solution to dryness, avoiding spattering. Determine nitrates by the regular phenoldisulfonic method, using five to ten cc of the acid and sodium hydroxide as the base.

Determination of Ammonia, Amino and Complex Organic Nitrogen

To the original black digested solution of the sample which is now cool, add twenty-five cc water. Cool to a point where the hand can be held on the flask without discomfort. Add five grams of fine potassium chlorate or sodium chlorate if potassium is to be determined. Leave standing until the solution is a clear red and most of the foaming has ceased. Gentle heating with shaking may be necessary to start the reaction, but do not heat above 70° C. The sample is usually ready to distill in five to fifteen minutes. The sample may be left standing over night, which results in almost complete oxidation before distillation. Wash down the sides with fifty cc water and connect to the condenser arrangement as set up for nitrates. Too rapid heating with much excess chlorate may cause an explosion, but as a rule very little of the chlorate is left and in the dilute solution the explosion is harmless.

As soon as green fumes cease, distil vigorously into an Erlenmeyer. If the distillate tends to get colorless and does not remain a strong yellow color, bubble chlorine dioxide gas in the solution as in the nitrate determination. Continue the distillation until the water is distilled off and a nearly colorless sulfuric acid solution is left. This is told by the rise in boiling point and the condensing back of acid on the neck of the flask. Disconnect the digestion flask and wash out the condenser into the Erlenmeyer flask. Treat just as was done with the distillate of nitrate nitrogen. If much nitrogen is expected an aliquot should be taken or the original sample made quite small.

The digestion residue is now colorless and contains the other inorganic elements. By dilution and nearly complete neutralization of the sulfuric acid with sodium hydroxide, a clear, almost neutral, solution of the remaining inorganic elements will be obtained and aliquots may be taken for the determination of the elements desired by the standard methods in clear

solution, with the exception of sodium, the halogens and sulfur.

EMERY M. EMMERT

DEPARTMENT OF HORTICULTURE,
IOWA STATE COLLEGE

THE NEPHELOMETER IN MYCOLOGY

THE use of the nephelometer in the biological sciences is not new. It has been used to measure the growth of bacteria in nutrient solutions and has been adapted to the determination of protein, using sulfosalicylic acid as a precipitating agent. A method of determining nitrogen as ammonia, using a modified Nessler's reagent, has been worked out for extremely dilute solutions of ammonia or ammonium salts.

It occurred to the writer that a water culture of a fungus such as oidium could be determined by this method, provided the hyphae were broken up sufficiently. A culture of oidium in a dilute nutrient solution was shaken up in a shaking machine for various lengths of time and with the addition of different acids and bases. Attempts to use glass beads and clean sand as aids in the breaking up process failed because of the colloidal silica formed by the rubbing together of the particles.

Best results were obtained by using a glass-stoppered, wide-mouthed bottle approximately four times as high as the diameter and fitted inside with a cone-shaped roll of nichrome gauze. This cone should be tall enough to have the tip pressed upon by the glass stopper and thus prevent its shaking about. The bottle should be not over one third or one fourth full of the culture and should be shaken rapidly for at least twenty minutes. The culture being dashed back and forth through the wire gauze at an angle is torn to pieces small enough to stay in suspension for a considerable time. The culture should be neutral as even a slightly acid solution attacks the wire under these conditions and a colored solution results which is useless for a nephelometric determination. It may be found desirable to remove the gauze cone and add sufficient concentrated sulfuric acid to make a 10 per cent. solution and again shake for five minutes. The increased specific gravity of such a solution will help to keep the particles from settling out. Every effort must be made to keep any turbidity other than that due to the fungus from developing. If any calcium was used in the nutrient solution the addition of sulfuric acid will cause a very objectionable precipitate. In any case a part of the sample should be filtered and the filtrate run as a blank.

If it is merely desired to compare various solutions, one of them may be used as a standard, or a suitable standard can be made by adding one drop of saturated silver sulfate solution to 200 cc of distilled water and adding just enough dilute HCl to completely precipitate the silver. This solution darkens after a time but is good for several readings.

By observing the precaution necessary to successful determinations with a nephelometer the writer has found that the readings are proportional to the amount of growth present in the solution.

GEORGE HOCKENYOS

UNIVERSITY OF ILLINOIS

AN ACCURATE METHOD OF TAKING READINGS ON EXCEEDINGLY LOW ROCK DIPS

IN regions of nearly horizontal bedded rocks it is practically impossible to make accurate dip readings with a Brunton compass where the dip is less than fifty feet per mile. It is however often essential in deciphering low structures to get dependable results quickly in the field. The procedure described below was found to meet this requirement very satisfactorily.

Tie a long nail on one end of 100 feet of fish-line. Drive this nail into the bed of rock of which the dip is to be read. Stretch the fish-line across the rock face. Usually a 50-foot exposure or a 25-foot exposure can be had. Such lengths facilitate calculation. Mark the fish-line at 25, 50 and 75-foot intervals by tying on pieces of red yarn or silk thread. Have a small line-level such as is commonly used by carpenters placed over the center of the line and raise the line until the bubble reads level. Then with a carpenter's 6-foot folding rule, note the dip and make the calculation.

EDWIN ALFRED FILMER

CORNELL UNIVERSITY

SPECIAL ARTICLES

THE ACTION OF GLUTATHIONE AND HEMOGLOBIN ON THE GROWTH OF FIBROBLASTS IN VITRO

FOR some time it has been known that fibroblasts and epithelial cells proliferate indefinitely in vitro in a medium composed of equal parts of plasma and embryo juice.[1] If the factors responsible for the unlimited growth of tissues in such a medium could be

[1] A. Carrel, "Artificial Activation of the Growth in Vitro of Connective Tissue," *J. Exp. Med.*, 17: 14, 1913; "Tissue Culture and Cell Physiology," *Physiological Review*, 4: 1, 1924; "Les Milieux Nutritifs et leur Mode d'Emploi dans la Culture des Tissues," *C. R. de la Soc. de Biol.*, 96: 603, 1927; Fisher, A., "A Three Months Old Strain of Epithelium," *J. Exp. Med.*, 35: 367, 1922; A. Carrel and A. H. Ebeling, "The Multiplication of Fibroblasts in Vitro," *J. Exp. Med.*, 34: 317, 1921; "Survival and Growth of Fibroblasts in Vitro," *J. Exp. Med.*, 38: 487, 1923.

known, it seems probable that much could be done to accelerate the normal processes of repair. Such knowledge would also assist us in understanding the mechanism of the development of malignant tumors. As a means to these ends it seemed desirable to synthesize, if possible, a medium of known chemical composition in which the indefinite proliferation of connective and epithelial tissues would take place. The first step in this direction was made with the discovery that fibroblasts and epithelial cells cultivated in proteoses from certain proteins multiplied extensively, although for a limited period.[2] It was shown later that peptones and the lower fragments of the protein molecule also contribute to the nutrition of fibroblasts.[3] Recently a pure strain of sarcomatous fibroblasts was found to proliferate slowly for a period of fourteen to twenty days in an artificial medium composed of Tyrode solution, nucleic acid, glycocoll and the peptic digestion products of either casein or crystalline egg albumin.[4] Normal fibroblasts in pure culture also multiply for a limited time in this medium. The rate of growth, however, decreases with time, and death of the cells follows. One could attribute the deficiency of this medium in part, at least, to the absence of substances required for the functioning of the respiratory mechanism of the cell. It was also reasonable to suppose that a given oxidation-reduction potential might be as important for cell multiplication as a definite osmotic pressure or hydrogen-ion concentration. Therefore, a study was made of the effect on the nutritive value of this medium of adding to it, (1) ash of liver, (2) glutathione and (3) hemoglobin. The glutathione used in these experiments was very kindly furnished for this purpose by Dr. Carl Voegtlin, of Washington, D. C. Ash of liver was employed because it contains both iron and copper and has been shown to be beneficial in the treatment of anemia of rats.[5] Also it has been found that the peptic and tryptic digests of liver furnish all the elements essential for the complete nutrition of sarcomatous fibroblasts.[6] For this work a pure strain of sarcomatous fibroblasts of rat Sarcoma No. 10 of the Crocker Foundation was used, and also a pure strain of normal fibroblasts of the rat. The colonies were cultivated in Carrel "D-3" flasks.

Practically no effect on the area of growth of sarcomatous fibroblasts was obtained by adding either ash of liver or glutathione to the artificial medium of casein digest, glycocoll and nucleic acid.[7] However, the condition of the cells was slightly improved and an increase in the thickness of the growth occurred. When both substances were added to the artificial medium, there was a small but very definite increase in the rate of growth especially noticeable in the second passage, *i.e.*, after about twelve or sixteen days. They also caused a marked improvement in the condition of the cells. When hemoglobin was added to the mixture of casein digest, glycocoll and nucleic acid, there was also a slight increase in the nutritive value in this mixture for sarcomatous fibroblasts and a slight lengthening of their period of survival. Glutathione, ash of liver and hemoglobin were then all added together to the artificial medium. The mixture of these three substances with casein digest, glycocoll and nucleic acid was found to have an astonishing effect on the multiplication of sarcomatous fibroblasts. The growth of new tissue was approximately 100 per cent. greater in the first passage than that in the original medium of casein digest, glycocoll and nucleic acid, and was as great as that produced by embryo juice. Moreover, the same rate of growth continued for five passages, or about forty days. Toward the end of this time, the growth became thinner and the condition of the cells was not as good as that of the controls cultivated in embryo juice. The central fragment of the colony was surrounded with dead cells and some dead cells were scattered throughout the culture. This might be accounted for in one of three ways: (1) some essential substances are still lacking in this artificial medium; (2) the medium contains some substance which is toxic or (3) the proportion of the different constituents of the medium to each other is not correct. Subsequent experiments demonstrated that equally good results were obtained when only glutathione and hemoglobin were added to casein digest, glycocoll and nucleic acid. The ash of liver seems to have no effect when hemoglobin is also used.

[2] A. Carrel and L. E. Baker, "Action des Proteoses sur la Proliferation Cellulaire," *C. R. de la Soc. de Biol.*, 95: 359, 1926; "The Chemical Nature of Substances Required for Cell Multiplication," *J. Exp. Med.*, 44: 503, 1926.

[3] L. E. Baker and A. Carrel, "Nitrogen Metabolism of Normal and Sarcomatous Fibroblasts in Pure Culture," *J. Exp. Med.*, 1928 (in press).

[4] L. E. Baker and A. Carrel, "The Effect of Digests of Pure Proteins on Cell Proliferation," *J. Exp. Med.*, 47: 353, 1928; A. Carrel, L. E. Baker and A. H. Ebeling, "The Effect of Certain Pure Chemical Substances on the Multiplication of Sarcomatous Rat Fibroblasts," *Archiv f. exp. Zellforsch.* 5: 125, 1927.

[5] E. B. Hart, H. Steenbock, J. Waddell and C. A. Elvehjem, *J. Biol. Chem.*, 77: 797, 1928.

[6] L. E. Baker and A. Carrel, "Effect of Liver and Pituitary Digests on the Proliferation of Sarcomatous Fibroblasts of the Rat," *J. Exp. Med.*, 47: 371.

[7] In all cases the tissues were embedded in a coagulum of chicken plasma from which the serum was removed by washing with Tyrode solution. The artificial medium was made up in Tyrode solution and used as a fluid medium on top of the coagulated plasma.

It is possible that the hemoglobin fulfils the same function as the ash, only more efficiently. When normal fibroblasts of the rat were used in place of sarcomatous fibroblasts, they also were found to proliferate more rapidly when glutathione, ash of liver and hemoglobin were present in the artificial medium, but the results were not as marked as were those with sarcomatous fibroblasts. As has been observed before, normal cells are more subject to the deficiencies of artificial media than are sarcomatous fibroblasts. It seems probable that hemoglobin and glutathione function not only by regulating the respiration and oxidation or reductions within the cell but also by causing a desirable oxidation-reduction potential in the medium. This hypothesis will be tested in the near future. Without doubt, they furnish constituents which are essential as foods for the synthesis of cell protoplasm.

LILIAN E. BAKER

ROCKEFELLER INSTITUTE,
NEW YORK, N. Y.

ZOOPHILOUS MOTHS[1]

THE night-flying moths in the vicinity of Iguazú Falls (Misiones, Argentina) have a perversion of taste remindful of the perverted food habits of the keas of New Zealand.

The writer, in company with Dr. Eduardo Del Ponte, first became acquainted with their abnormal habits while investigating the anopheline mosquitoes of the Rio Alto Paraná for the Departamento Nacional de Higiene de Argentina (June, 1927). Mr. Adams, manager of the hotel at the Cataracts, related to us that swarms of night-flying "butterflies" caused his horses considerable annoyance by "getting" into their eyes, and the consequent irritation sometimes resulted in temporary blindness. We thought they could not be true butterflies, as these are diurnal; neither could we believe they were moths, as it seemed incredible that they could have such habits. However, Mr. Adams insisted the insects were like butterflies.

During our stay we used two of Mr. Adams's horses as bait to attract mosquitoes. The first evening a moth was seen to alight on the lower eyelid of one and immediately, as we could observe by means of flashlights, it extruded its proboscis and began to feed upon the secretions. We were unable to capture the moth as the horse frightened it away by winking its eye. At this time of year (the winter season) moths were very scarce and no more were seen. However, our observation confirmed Mr. Adams's statement that the insects were butterfly-like, and also gave the clue to the correct group of insects to be implicated, namely, the Geometridae.

The following October, in company with Mrs. Shannon and Señor Marcos Reisel, I was again making anopheline investigations at the Iguazú Falls and as the season was favorable, we were able to collect a number of moths off the horses. A surprising thing is that a large number of species, representing several families, including even the Sphingidae, are attracted to the horses.

Dr. H. G. Dyar (National Museum) kindly identified the moths and their names are given below:

LIST OF SPECIES

Pyralidae:	*Pyrausta* sp.
Notodontidae:	*Crinodes beskei* Hubn.
Geometridae:	*Pergama polygonaria* H.-S.
	Pergama speciosata Gn.
	Pergama pumaria Feld.
	Meticulodes xylinaria Gn.
	Pero stolidata Gn.
	Pero maculicosta Warr.
	Dichromatopodia deflexa Warr.
	Pterocypha tabascana Schaus.
Sphingidae:	*Xylophanes tersa* L.

Upon our return to Buenos Aires, we related our experience to Dr. Carlos Bruch (local entomologist) who then told us that in 1904 he received a letter from a friend in Paraguay (eastern part?) saying that his horses were being troubled by "mariposas" coming to their eyes, producing thereby great irritation. This is the only additional record so far obtained.

The reason for this perversion of habit is not plain. Mr. Adams suggested that possibly the moths were attracted by the light reflected from the eyes of the horses. The fact that we saw numerous moths sucking the eye secretions, and also visiting other parts of the body and endeavoring to feed on the perspiration, indicates clearly enough that they desire the food, salt or moisture contained therein. The last factor appears of small consequence as the region is well supplied with moisture by ample rainfall.

We are also left to wonder why so many kinds of moths choose horses (and probably cattle as well) as a source of nourishment. But this in itself may help to explain why they have developed their anomalous taste. Possibly, the explanation lies in the fact that, in spite of the superb development of plant life in the region, flowers (the usual source of food for moths) are very scarce and, therefore, the moths are forced to seek food elsewhere. This is corroborated to some extent by finding many kinds of flower-feeding flies and bees, existing in the region, feeding

[1] Contribution from the Instituto Bacteriologico, Buenos Aires.

upon carrion and fecal matter; apparently, they are likewise forced to obtain their food from unnatural sources due to lack of flowers.

Another explanation may be based on a craving of the moths for salt. It is well known that butterflies alight on people and probe about on the skin with their proboscides as if trying to absorb the free perspiration. It is commonly believed that their object is salt.

Perhaps this region shares in common with certain large areas of Brazil an absence of salt in the soil. It may be of interest to investigate the salt requirement of insects and the power of salt to attract adult insects after they have been deprived of it in the larval stage.

R. C. SHANNON

THE FUNCTIONAL FORM OF THE CONSTANT OF MASS ACTION AND ATOMIC ACTIVATION

IT was shown by the writer in a previous paper (*Phil. Mag.*, 5, 263 (1928)) that the constant of mass action of an interacting gaseous mixture may be a function of the volume and masses of the elemental constituents as well as of the temperature. The differential equations of a reacting mixture were subsequently given (*Phil. Mag.*, 5, 620 (1928)) and applied to certain reactions by the help of the orthodox gas equation $pv = MRT$. In a paper that recently appeared (*Phil. Mag.*, 5, 1191 (1928)) it is shown that according to thermodynamics the gas equation should have the form $pv = M\xi RT$, where ξ is a function of the number of mols of the gas, its volume v, and absolute temperature T, which differs inappreciably from unity under ordinary conditions, but which is less than unity when the volume is very large, or the molecular concentration very small. It appears therefore that the law of mass action, as usually understood, breaks down completely if the volume of the gas is sufficiently increased. The pressure at which this begins to take place can not at present be predicted theoretically—probably it is extremely low—and it might therefore form the subject of some interesting experimental investigations.

It also follows from this result that strictly under all conditions the constant of mass action is not only a function of the temperature but also of the volume and masses of the constituents. This indicates that what happens to two molecules in a gas does not depend only on their chance of encounter, but on their previous encounters with other molecules during which they get activated for chemical change. It will therefore be of interest to see if some indirect evidence exists indicating that such activation may take place.

If the temperature of a gas is increased the spectrum emitted undergoes a change. This shows that the emission of the spectrum is associated with molecular collisions and their violence. Some experiments by Liveing and Dewar show besides in a striking way that the light emitted depends on the persistence of the effect of collision, or activation of the molecules. Thus if a small quantity of NaCl is put into a flame its spectrum shows the D lines of sodium sharply defined. On adding more salt the breadth of each line is increased, and on further addition of salt a further broadening of the lines takes place till a stage is reached at which they coalesce into one broad band.

The effect of one kind of atom on the light emitted by another is shown by the spectrum of the carbon arc containing a salt. The lines in the spectrum due to the salt are displaced when the pressure of the air is changed, showing that the effect produced in an atom of a salt molecule through collision with an air molecule persists for a longer time than the period between two consecutive collisions.

A mixture of PH_3 and air explodes if suddenly expanded beyond a certain limit. This remarkable effect was first observed by Houton de Labilladiere and studied in detail by J. V. D. Stadt, and found to be due to the oxygen present. A gaseous mixture of PH_3 and O_2 at ordinary temperatures and pressures does not interact, but if suddenly rarefied combination takes place with explosion. If the mixture is allowed to stand for some time at 50° C. a gradual decrease in pressure of the mixture takes place till a state is reached at which explosion occurs. The phenomenon possesses other peculiarities, one of which is that water vapor has a retarding effect on the explosion.

Chemical combination between molecules may be induced by ultra-violet and other radiations. The activity thus given to molecules may by contact be imparted to other molecules.

The foregoing results show that a molecule may undergo a temporary change through interaction with other molecules, and in other ways. Chemical interaction must be affected by these changes, and render the constant of mass action of a gaseous mixture in some cases appreciably a function of its volume and masses of the constituents as well as of the temperature. If the pressure undergoes a continual change, the average activation of a molecule at any instant is likely to differ in nature and magnitude from that corresponding to a state of equilibrium, an effect which is probably connected with the experiments with PH_3 described.

R. D. KLEEMAN

SCHENECTADY, N. Y.